POWER PLANT ENGINEERING

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Oil Refinery Power Plant

SUPPLYING CURRENT TO NEW RIVERSIDE REFINERY PLANT AT LOUISVILLE, KY. BY A. W. WILLIAMS

ONE OF THE MOST complete power plants that has ever been erected in the Louisville district is that completed a few months ago at the new Riverside refinery of the Standard Oil Co. of Kentucky, at Louisville.

It was due to the rapid development of Kentucky's oil industry, which has developed from almost nothing to nearly 800,000 bbl. of oil monthly, within 5 yr., that the Standard Oil Co. decided in 1916 to erect this plant at Louisville, on the Ohio River, where it would be close to several good coal fields, and where it would be midway between the eastern and western Kentucky oil fields. Work was started on the plant in May, 1917, and original plans were finished this summer. Since that time the company has started work on enlargement of certain sections.

The new plant is of steel and concrete construction almost throughout, some brick work being used, principally fire brick around stills, retorts, etc. Due to the fact that this plant was erected during a period when labor and material were at the war levels it was an expensive one to build, and the total cost is estimated at figures running between $2,000,000 and $3,000,000. This plant was constructed for the purpose of manufacturing gasoline, the daily capacity being 2000 bbl., while it refines the oil to a very low grade, the lowest runs consisting of coke and road oil. It is equipped to take over oil that has been run through skimmer plants, or crude oil direct from the wells, as it can refine much lower than the so-called skimmer plants. A force of 200 to 250 men were employed during the greater portion of the construction period.

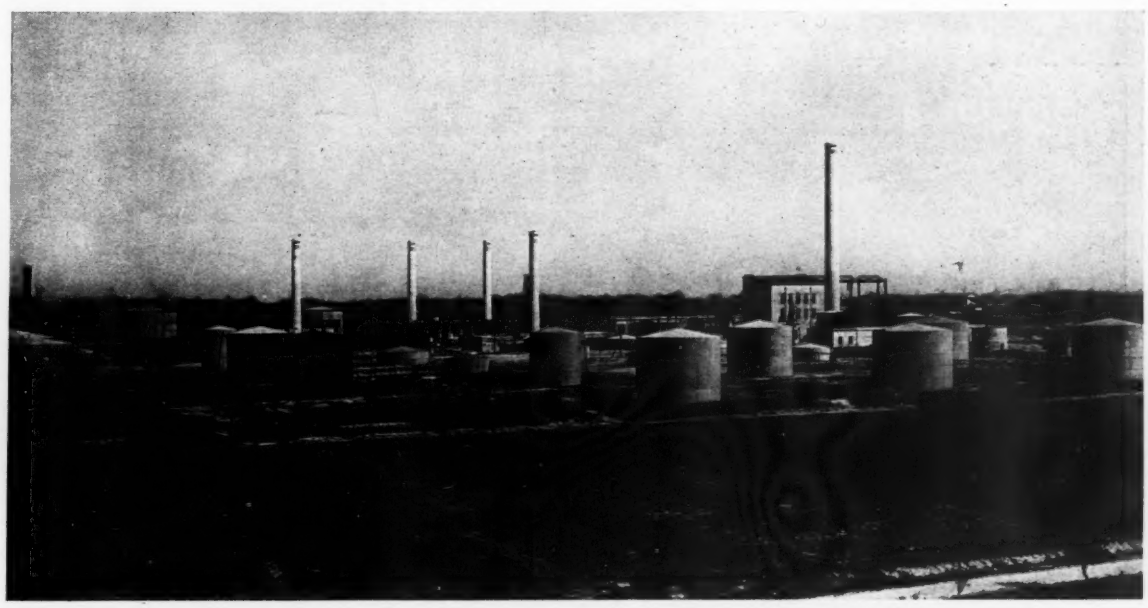


FIG. 1. GENERAL VIEW OF THE RIVERSIDE REFINERY

Excavations required weeks in the digging, and a great deal of ditching had to be done for the oil lines, water lines, etc. It is estimated that there is at least 50 mi. of pipe, 4-in. or larger, within the company's enclosure. A total of 12,000,000 cu. yd. of concrete and 750,000 lb. of reinforcing steel were used in the construction. About 5,000,000 fire and common brick were

utilized. The company has 360 acres of land, lying flat and just above high water, with a frontage of 2200 ft. on the Ohio River, with equipment at the landing for loading or unloading barges. The sewerage system includes 1700 ft. of 36-in. sewer pipe alone, besides much smaller pipe. The entire property is tiled, even the tank field being piped, with all water going to a concrete baffle box, where the oil is removed and pumped back to the plant, nothing but clear water reaching the river. The original tank field contained 55 tanks of various sizes, but a number of new tanks have since been completed.

Although this plant is constructed in a fireproof manner throughout, oil is a dangerous substance, and the company has its private fire-fighting equipment, consisting of six hose reel companies. High pressure water pipes for fire purposes only, extend through the plant. The offices, garage, etc., are located at the southern end of the property, while the workingmen's community houses are also well removed from the plant. In erecting this plant the company built on the self-sustaining principle, with the result that the completed plant buys raw material, and makes whatever it needs. It has complete machine shops, forge rooms and carpenter shops.

The first thing done in laying out this plant was to lay out 6 mi. of private switches and tram lines, all of standard gage. The main offshoot switch on the north side is equipped with a tank car filling rack for 36 cars. The company has a locomotive crane for handling coal and equipment from one section of the property to another, and also a dinky locomotive and a few cars. The dinky pulls work trains carrying employes to the city limits, and does the switching to and from the Kentucky & Indiana terminals, which connect with nine trunk lines.

After laying the switches, the first building erected was the shop building, divided into three sections, and thoroughly equipped for making all repairs, as well as for use in the construction of the remainder of the plant. The building is of concrete, steel truss and metal roof, 290 by 45 ft., divided 40 ft. to the carpenter shop; forge shop, 125 ft.; machine shop, 125 ft. The forge shop is equipped with acetylene welding equipment, complete forges, and full metal working equipment. The machine shop is equipped with all machinery needed in the maintenance of the power plant and refinery, including a 5-ft. swing radial drill, a 24-in. swing lathe, an 18-in. high speed lathe and cutting and threading machinery, equipped for handling 4 to 12-in. pipe. Sensitive drills, shapers and other pieces of machine shop equipment complete this department. The carpenter shop is equipped with power machinery, and is complete, part of the furniture used in the office being made here. The mechanical shops, which haven't an equal in any industrial plant in that section of the country, were of prime importance in construction of the plant. The second building was the store house, 50 by 80 ft., of the general type of construction used in the mechanical

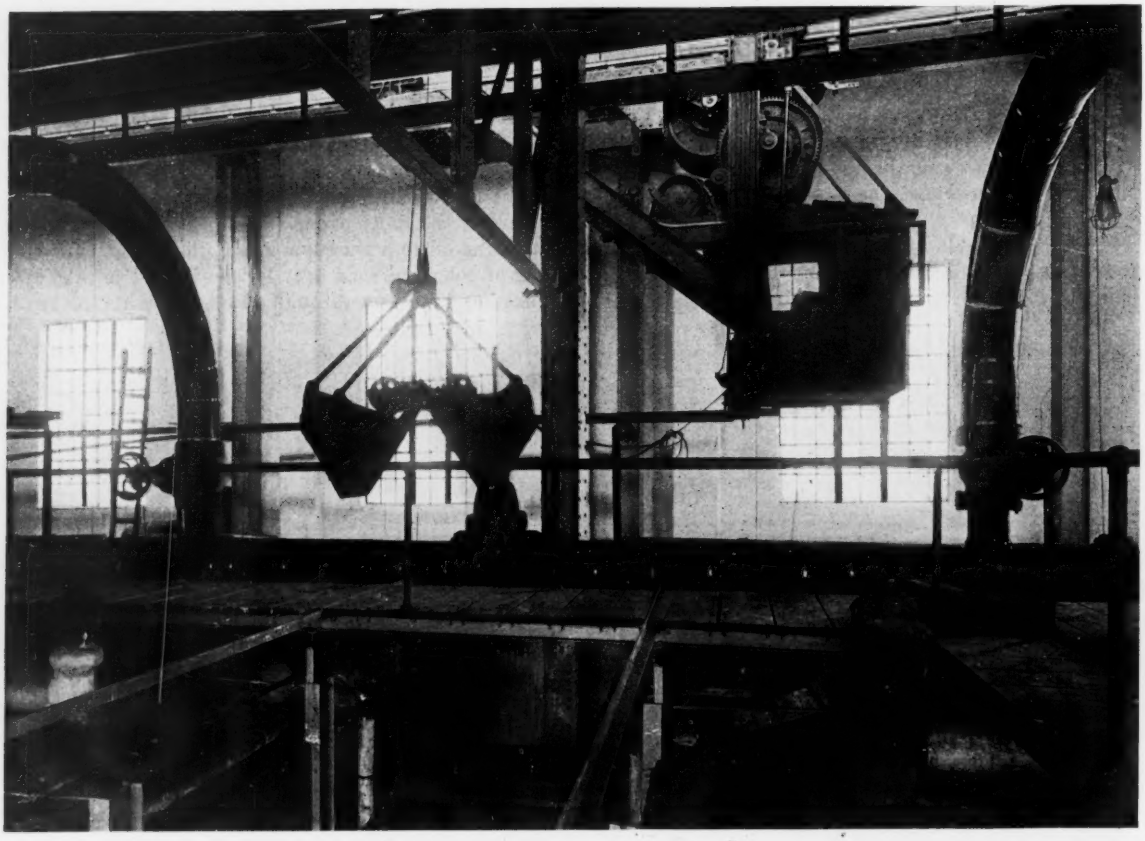


FIG. 2. MONORAIL CRANE FOR COAL HANDLING

shops, and equipped to carry a big stock of valves, asbestos, lead, pipe and other supplies and equipment used in the plant. The first aid room is located in the store house, and is equipped with instruments, beds, operating chair, medicine cabinets, etc., while half a dozen doctors are on ready call when needed.

Power Plant

The pump house, which is located on the ground floor of the power house, contains two turbine driven centrifugal boiler feed pumps, and one circulating pump of the same type. Boiler feed water is secured from any of three sources. Under normal conditions condensate from the steam stills, at a temperature of 140 to 150 deg. F. is used, but when the stills are not operating water is taken from a storage tank, or from the water mains through a softener. A feed water heater is not used, as the stills are only shut down for a comparatively short time. In addition there are also three emergency pumps, which can be used for feeding the boiler, and one 7 by 5½ by 10-in. high pressure pump delivering water at 125 lb. for cleaning turbines, ash sprays, etc.

Water for cooling purposes is pumped by two-stage centrifugal pumps, at the rate of 1500 gal. per min. from four 19-in. diameter wells, 113 ft. deep, and at an average temperature of 58 deg. F.

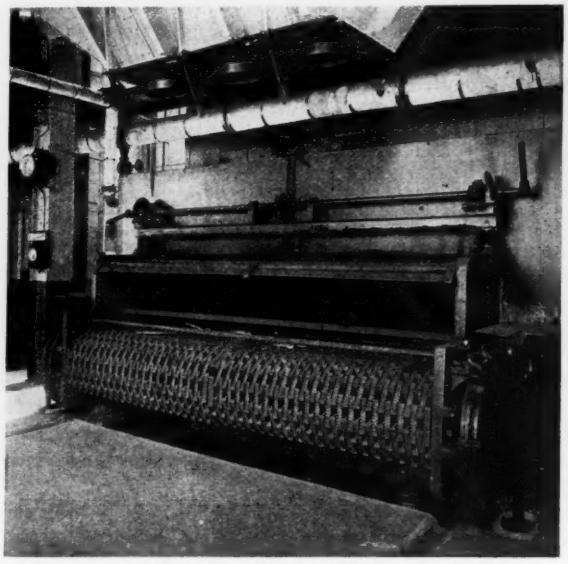


FIG. 3. CHAIN GRATE STOKERS FOR FIRING STEAM BOILERS

The power plant is erected on the two story plan, with the boilers 20 ft. above the ground level. Coal comes into the hoppers at the top of the plant, is automatically fed to the boilers, and the ash drops into concrete hoppers at the ends of the chain grates. These hoppers empty into gondola cars, which come in on the ground level under the plant.

The normal capacity of the boiler plant is 1500 hp. consisting of three water tube boilers of 500 hp. each, equipped with automatic chain grate stokers. Each grate has a surface of 132 sq. ft. The steam plant is equipped with all modern appliances, including soot cleaners, individual damper regulators on each boiler, feed water regulators, a water softening system, pyrometers, draft gages, steam gages, etc. The damper regulators are so equipped that they automatically shut off at 105 lb., and open again at 95 lb. steam pressure. A CO_2 indicator is found on each boiler. These boilers are jacketed in brick, covered with asbestos insulation, and steel jackets.

Water for the plant is supplied by means of three turbine pumps, connected to 26-in. wells, each pump having a capacity of 1500 gal. per min. These pumps are connected up to the water mains and through check valves to the separate fire mains, 35 lb. pressure being ordinarily carried, but which can be raised to 100 lb. with the fire pressure pumps. A fire tank having a reserve water capacity of 28,000 bbl. or 1,176,000 gal. is kept full for emergencies.

FIG. 4. CHAIN GRATE STOKERS FOR FIRING OIL STILLS DURING CONSTRUCTION

The coal handling equipment is unique. There is no lost motion, as the fuel is not handled by hand from the time it leaves the mines until the ash is dumped on low spots around the plant for filling-in purposes. Coal comes in on a switch, hung over a 12-car pit, so that either drop bottom or side drop cars may be emptied quickly into this pit. The concrete pits are equipped with submerging valves, so that the mine run or nut and slack may be kept wet to prevent firing, or in case of firing the whole 12 cars can be submerged. The company burns screenings, but can use mine run. In case of emergency coal by barge could be unloaded at the river front, and transferred to cars by the locomotive crane.

Close to the 12-car pit is the emergency supply, consisting of a big concrete pit, which can be submerged, and which has a capacity of 175 cars of coal. These pits are so large that it is not necessary to stock them high; therefore there is not much chance of soft bituminous coal firing, as such coal rarely fires unless stacked more than 12 ft. high. In the event that coal supplies failed to arrive, the locomotive crane could transfer coal from the large pit to the smaller one rapidly.

In handling coal from the coal pit to the coal bunkers

at the top of the plant, which feed coal directly to the stoker hoppers, a two-ton electric crane carrying a 2½-yd. bucket is employed and operates on a monorail hung from the roof of the power house, traveling out over the coal pit on the monorail. This electric crane has a speed of 500 ft. per minute, and lifts 150 ft. per min., the operator riding in the cab and handling his levers from that point. The monorail consists of a 24-in. I beam, but the crane wheels operate on two 30-lb. rails, clipped to the I beam, thus eliminating wear and tear on the beam, and at the same time allowing for greater speed and ease of operation. The grab bucket picks up approximately 3700 lb. of coal at one filling from the pit, runs into the plant, unloads, and makes the round trip in about 3 min. The bunkers have a 24-hr. coal supply when full, each having a capacity of 450 tons.

The unloading of ashes from the lower hoppers is comparatively easy, cars coming under the hoppers on the ground level, and the ashes being released by air controlled gates directly to the hopper cars.

Generating Equipment

Electric power is generated by two 350-kw. 2300-v. 3-phase turbo-alternators operating at 3600 r.p.m., located

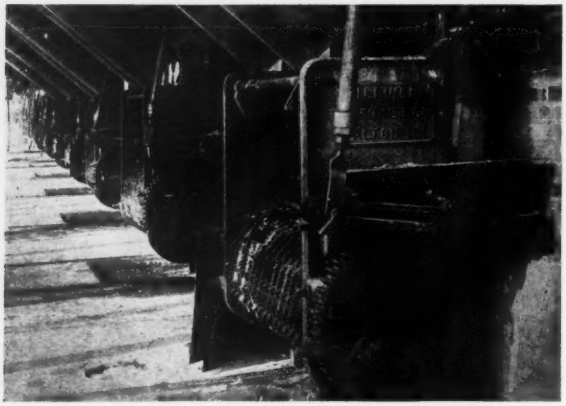


FIG. 5. STOKERS UNDER OIL STILLS SHOWING CHUTES FROM COAL BUNKER TO STOKER HOPPERS

in a separate building, 60 ft. from the boiler house. These units are operated non-condensing and the exhaust is used in various oil refining processes.

The oil pump house which pumps oil from tanks to stills, stills to tanks, or from cars to tanks, etc., is equipped with fifteen pumps of various sizes, with a manifold field outside of the tank house, which is arranged with systems of check valves, etc., to pump any combination on the premises.

The refining plant proper is built for 2000 bbl. of finished products every 24 hr. on the continuous process, making gasoline, water white kerosene, coke and road oil. The refinery consists of 30 high pressure tube stills, arranged in two groups of 15 stills each; four crude stills and two steam stills. The 30 stills are in one long line, and are connected up underground with three concrete stacks. Placed at each still is a 28-ton coal magazine, which feeds coal directly to the automatic stokers which fire each still, the steel magazines being connected up with two steel spouts to each stoker. The coal magazines are loaded by the locomotive crane from cars of slack. Ashes from the stills drop to underground ash pits, and are later carried by a vacuum system, to a large ash pit, from which they are loaded on cars by the locomotive crane.

There are five concrete smokestacks, the largest being at the power plant, two at the group of 30 stills, one at the steam stills and one at the crude stills. A sixth stack is found at the sulphuric acid reclaiming plant, where the sulphuric acid used in refining is cleaned and re-used. This stack is of glazed tile to resist the action of the acid. The acid plant is equipped with shallow lead lined, baffled pans, heated by furnaces on the ground level, the pans being 6 ft. above the surface. There are several stills used in this department for refining the acid.

The interesting points about this plant are many, but the ones that stand out the most are the many labor saving ideas that have been used, especially in the matter of fuel handling both in the power plant and at the stills.

To Protect Iron From Rust

A method of protecting iron from rust, for which very durable results are claimed, has recently been described by Prof. Barff in the Schweizerische Elektrotechnische Zeitschrift. The iron is first heated to a red heat and then treated with superheated steam, which produces a superficial coating of black iron oxide which offers complete protection against rust. The coating is extremely hard, adheres firmly, and will resist the action of emery cloth for a considerable time. If the temperature is raised to 650 deg. C. (1202 deg. F.) and the treatment continued for 6 hr., it will resist the action of a file. Exposure to air, moisture and rain for 6 wk. did not produce any appearance of rust.

Again recommendation is made that the Government invade the power plant field. In the report of the Federal Trade Commission on Private Car Lines, after calling attention to the need of small packers and shippers for refrigeration facilities in distributing meats and fruits, the recommendations are made:

1. That the Government acquire all cars used for transportation of meat animals or that such cars be owned and operated by the railroads under Government license regulation.

2. That the Government own all refrigerator cars and *all necessary equipment for their operation,* or that such cars and equipment be owned and operated by the railroads under Government license regulation.

This will include car shops, cooling and icing stations for artificial and natural ice, and, presumably, refrigerated warehouses.

Whether Governmental regulation of the handling of the refrigerating equipment needed for food transportation and distribution is necessary or not may be an open question, but Government ownership and operation is as indefensible in this matter as in the matter of the railroads themselves, and this recommendation is another manifestation of the "itch" of Government officials to increase the direct activity of the Government in industry, a policy which experience has shown to be costly and to reduce both quality of service to the customer and efficiency of operation.

FUEL CONSERVATION LETTERS

By Joseph Harrington, Formerly Administrative Engineer for the State of Illinois

Feed Water Heating. Letter No. 21

REFERENCE to a diagram illustrating the losses of heat in a power plant show one outstanding fact—the heat rejected from the engine or turbine is so much greater than any of the others that it overshadows them all.

In the condensing plant this loss has to be suffered because the advantages derivable from the production of a vacuum are greater than those sacrificed in producing such vacuum. In the noncondensing plant, however, which includes the vast majority of small plants, the heat rejected in the engine exhaust is a dead loss unless it can be recovered and returned to the system.

The only practical way is by using it to heat the cold water of the boiler feed. There is a saving of 1 per cent for every 11 deg. F. that feed water is heated. Assuming that water may readily be heated from a temperature of 60 to 210 deg., it will be observed that nearly 14 per cent is the amount of the saving. The feed-water heater is also partly a water purifier, many of the solids carried in solution being precipitated when the water is heated. Little or no excuse can therefore be advanced for not using a feed-water heater and catching as much as possible of the heat that would otherwise go out the exhaust pipe.

The effect also on the boiler itself is very marked. Pumping cold water into a boiler introduces local strains that are dangerous and may sooner or later result in a fracture of the plates. This, of course, means a boiler explosion. No sane water-tender would open his feed valve if, due to an accident to his feed pump, the water in the boiler should get so low as to overheat the plates or the tube ends, until he has cooled down the boiler to a point where the cold feed-water would not hurt it. This differs from feeding cold water into the boiler at any time in degree only. Pumping water at 60 deg. F. into a boiler heated to a temperature of 350 deg. must of necessity create a local cold zone, and the contraction due thereto will impose serious strains on the metal structure.

Feed-water heating has, therefore, not only matters of economy in its favor, but considerations of safety that are so vital as to put the question outside the realm of discussion or in the class of debatable propositions. Even with pre-heated feed-water, it should be fed as uniformly as possible, sudden and wide fluctuations being avoided.

Any water-tender will agree as to the effect that cold feed-water has on his ability to carry steam. Many a plant which is just getting along so far as capacity is concerned, with cold feed-water, would carry the load easily if heated feed-water could be had. The writer has seen (as has every observant person) exhaust steam issuing from a dozen different pipes around the plant, and at the same time the pumps handling water that was many degrees lower than the 210 deg. F. usually considered the practical limit of the open feed-water heater. If your plant does not have a heater sufficiently large to take care of the boiler feed up to 210 deg. F. or if it is not doing so for any reason whatsoever, immediate and drastic action should be taken to put the heater in proper service. The heat in exhaust steam is just exactly as valuable as it is in the form of coal, or even more so; because no manual labor is required to extract it.

I would urge, therefore, that a thermometer be brought into play at once and observed carefully until there is no question about the feed-water being as hot as it can practically be made. As a matter of fact, there should be an indicating thermometer on every feed line, so that this important detail can constantly be watched for losses in efficiency. If you can combine partial purification with the heating, just so much the better.

In the large plant, the steam-driven auxiliaries should be numerous enough to provide heating, but no more. Any other auxiliary equipment should be driven by motors taking power from the bus-bars.

In the smaller plant, especially those where electric power is not generated, and all machinery is steam-driven, great care must be exercised to utilize all the exhaust possible. Feed water should first be heated to the limit, and any surplus exhaust used for heating, drying, process-work, and the like. In both cases, feed water heating comes first. Let's all see that this is properly attended to.

Recent Developments in the World's Power Industry

DIGEST OF REPORTS OF UNITED STATES CONSULS ON THE POWER SITUATION IN VARIOUS PARTS OF THE WORLD AND THE INFLUENCE OF THE RETURN OF PEACE. BY L. W. ALWYN-SCHMIDT

THE INTERNATIONAL problems of the power industry have not ended with the return of peace. They seem, in fact, to have become rather aggravated. There are several causes why this should be so. One, no doubt, is the release of the power industry from governmental control which now proceeds in the various countries and forces the industry back upon its own resources during a period when it does not seem always fit to resume this responsibility. As the result, there is a general desire for hastening as much as possible the process of re-adjustment. The fuel situation, which has been very unsatisfactory all through the war, has possibly become worse. In England, the miners have been on strike and the controversy over the nationalization of the coal mines is likely to produce still more friction between the coal mining owners and the miners. In Germany, strikes are frequent, and the French coal

FIG. 1. BOILERS AT LENS COAL MINES DESTROYED BY GERMANS—PHOTO BY INTERNATIONAL FILM SERVICE

situation does not show any signs of improvement, notwithstanding the addition of the Sarre coal fields to the existing French coal resources.

The power consumers, therefore, are anxious to see either an early settlement of the labor dispute all over Europe, or the replacement of coal as a source of power by any other power producer, as hydroelectric power for instance. Also, there is evidence of a general rise in the cost of power for the producer as well as for its consumer.

The electric power industry is having its share of the general trouble along with all power producers. While it is, however, as a rule, the small power producer and consumer who is most likely to suffer under conditions like the present, it seems that in the case of the electrical industry the tables are turned for once. The smaller electric power companies are weathering the storm apparently fairly well, while the large enterprises have great difficulties to meet all the requirements of their widely distributed organizations. As regards coal, the principal difficulty at the present time seems to be not so much the actual flow of the coal supply but the great variety in the shipments and the low grade of the coal which is supplied by the mines. This has been a condition existing all through the war, but the electric power stations had hoped that it would end with the return of peace. In the case of the smaller power stations, a remedy is possible in a careful sifting of the incoming supplies; this, however, seems to be not permitted to the large enterprises, which have to meet an enormous increase in the demand for power, giving them no chance whatever to diminish their production. Fortunately, business has been good with most of the public utilities all through the war and they have, therefore, the financial means of readjusting themselves, even if the technical equipment is not as perfect as might be desired.

LONDON IS CHAOTIC

AN INTERESTING example for the present situation in a leading city in Europe, is London. To the foreign power engineer the power situation of London must appear rather chaotic. It is, in fact, not very satisfactory from the production point of view; even before the war steps had been taken for a thorough reform, the execution of which, however, was interrupted by more urgent duties. At the present moment London is supplied with electric power by 11 different companies, which, however, do not all operate their own power houses. The sale of electric power in London increased during the war at the rate of 24,000,000 Board of Trade units, being 233,000,000 units during the year 1918. The problem of the central station of London at the present time is the steady increase in the operation cost. This must have been a rather astonishing phenomenon for the English power engineers, although easily explained by the peculiar conditions of the war, as the English power industry was accustomed to a fairly steady expense sheet in pre-war times. Approximately 50 per cent of the revenue was estimated in pre-war times as a fair expenditure for a well-regulated electric power enterprise. It is now 65 per cent in the case of London and there are power stations showing a considerably higher percentage. As an average, operation expenses have risen at the rate of 75 per cent against the figures of 1914. The London power problem is aggravated still by the enormous increase in the business of the subway and electric tramway system. One company alone which used to handle 115,000,000 passengers in 1913 is now handling 170,000,000 persons, necessitating a considerable increase in the consumption of power. This means also larger coal supplies for London. If one considers that London hardly knows our American central heating system and that coal is burned in each individual room in open fireplaces, one may be able to get an impression of what this increase in the consumption of coal means during a time when railroad communications are not of the best and coal is likely to become scarce at any moment.

Most of the English power stations in large cities report good business during the last year. All, how-

ever, note the increase in the cost of operation and the difficulty of obtaining fuel.

The Netherlands and Belgium Must Use Coal

The power situation seems to go from bad to worse in such countries as the Netherlands and Belgium. These two countries, being practically flat, have no other possibility of producing power than by the use of coal; the insecurity of the European coal supply, therefore, is heavily felt in both markets. Belgium is somewhat better situated than her neighbor, Holland, because she has sufficient coal to keep her industries going, and on the strength of these resources it has just been decided to give Belgium an electric railroad system. The start is to be made with three lines leading from Brussels to Antwerp, Luxembourg and Ostend, respectively. However, the situation remains very critical in the Netherland, especially under the aspect of the labor troubles in the British and German coal fields, which have heretofore supplied great quantities of coal to Holland. A proposition was made some time ago to employ wind as a generating power for electric power and light in Holland. Holland is today possibly the most extensive user of wind for the generation of power for milling, and the idea of employing wind for generating electric power, therefore, is not as strange to the mind of the Netherlandish engineer as it might be to our own.

Water Saves Finland

Finland looks ahead to a very prosperous time, during which the great hydroelectric power resources of the country are most likely to play a considerable part. Finland is situated as to its hydroelectric power supply as favorably as, if not better than, her two Scandinavian neighbors. It is now estimated that Finland has at the present time a sufficient water power source to produce 3,000,000 hp. at normal level. Of this, one-third is estimated to be suitable for industrial uses. Only 150,000 hp. are developed so far, and even these are not giving their full load. The state owns at the present time rights to develop 140,000 hp. and is likely to acquire others. All in all there are known at present 79 waterfalls developing more than 5000 hp. Of these 23 are suitable for a development up to 10,000 hp., 19 can develop between 10,000 and 20,000 hp., 8 will give between 20,000 and 30,000 hp., 12 between 30,000 and 40,000 hp., 5 between 40,000 and 50,000 hp., 4 between 50,000 and 60,000 hp., 2 between 60,000, and 100,000 hp., while 6 are available for developments ranging between 100,000 and 300,000 hp. Of the largest waterfalls two are on the Ulea River. These are the Pyhakoski Fall with a drop of over 60 yd. and a possible development of 292,000 hp., and the Niskakoski with a drop approaching 40 yd. and a likely development of 157,000 hp. Finland will hardly have the means to develop these falls all herself, and the suggestion has been made already to have American capital entering this vast field of electrical enterprise. No doubt American power engineers and American capital would find a good reception in that market.

Coal Saved by Water Power in Sweden

As a rather interesting example of how the use of the hydroelectric power is reducing the consumption of coal in individual communities, the city of Stockholm owns an extensive electric supply organization drawing power from many different sources found in the waterfalls of the Swedish mountain ranges. Just now a new source has been tapped by the completion of the power station near Untran. This station can produce approximately 28,000 kw., half of which will be supplied to Stockholm. The transmission line has a voltage of 100,000 and the plant costs $8,000,000. It is estimated that the new power station will save the power consumers of Stockholm at least $4,000,000 which has been spent formerly for coal.

Norway, also is resolved to attack the problem of her permanent shortage of coal by making the most complete use of her hydroelectric resources. The result is a permanent trend in the direction of electrification of state railroads and other transportation systems. One example of this movement is the electrification of the mining railroad employed by the Aktieselskabet

FIG. 2. TYPE OF WINDMILL WHICH WILL BE USED TO DEVELOP ELECTRIC POWER IN HOLLAND—PHOTO COPYRIGHTED BY KEYSTONE VIEW CO.

Sydvaranger Malmgruber, which is replacing gradually all steam locomotives by electrical traction engines.

Undersea Transmission to Denmark

Denmark is now bent upon completing her original plan for supplying her citizens with electrical power from Norway or Sweden by means of cables laid under sea from the northern Scandinavian sources. The Nordsjaellands Electricitets of Sporvejs, Aktieselskab of Copenhagen, which already owns an undersea transmission cable, has just raised its share capital at the rate of $670,000,000 and is likely to extend its supply interests in Norway for the purpose of transmitting larger quantities of power. This development would have taken place much earlier. It has been, however, impossible for the company to buy the neeessary supplies. These, it is thought, will be now obtainable, which may have hastened the intended expansion of the enterprise.

Small water power resources are reported to exist

in Greece in the Peleponnesos and near Saloniki. The latter should be a welcome addition to the power supply of Saloniki, where the coal shortage was a chronic state of affairs even before the war, and will have increased much more during the last few years.

Interconnected System to Cover Spain

Some time ago it was reported that the Spanish Government had instituted a permanent Electric Commission to study the electrical possibilities of Spain. According to a preliminary report, the system as conceived by the commission would be a series of transmission lines passing through or near all of the important consuming centers which are on the north or south coast, with radial lines to Madrid, which is practically in the center of the country. Power would be generated at the larger waterfalls and also at mines, where coal of too low grade to be exploited commercially could be used to produce energy cheaply by being burned at the mine shaft. These steam centrals would be used principally

FIG. 3. THE LOTEFOS, NORWAY'S MOST FAMOUS WATERFALL—PHOTO COPYRIGHTED BY KEYSTONE VIEW CO.

during the droughts which occur at certain seasons in all parts of Spain, and in this manner there would be an abundance of power during the entire year. One of the greatest advantages to be derived from a national system, aside from the continuous supply of cheap power to all users, large and small, would be the unification of the frequency and voltage. The former is now standardized at 3-phase, 50 cycles, throughout Spain, and the latter would be regulated after more study of the needs of the principal industries. For the main branches of the transmission line it is recommended that the potential be not less than 120,000 v.

The lines will be in duplicate throughout, protected by a ground wire and provided with four telephone circuits. The posts may be of concrete and steel, spaced at an average distance of 410 ft. The insulators considered best are those of the suspension type, six elements in series. The estimated total cost of the 2728 mi. of transmission lines required is $25,090,000.

The state will entrust to a commission of experts experienced in hydroelectric problems and in the transportation of high power for long distances the final study of a general system to be constructed by the Government. In conjunction with hydroelectric power, to which preference will always naturally be given, a study will be made of the utilization of fuel of an inferior quality and low price, or of coal which occurs in regions incapable of being exploited on account of their great distances from consuming centers.

Australia Makes Plans

Outside Europe, the return of peace seems to have acted as a powerful impetus to electric power development. An English factory of electric power machinery recently received an order for an electrical unit of 5000 kw., which is to form the foundation for a large new power station in Adelaide, South Australia. The new power station is to form an extension of the present supply service maintained by the Adelaide Electric Supply Co., Ltd. This company has taken a lease for a site of 20 acres with a river frontage of 500 ft. On this space a power station will be erected at a cost of $1,250,000. Power will be distributed within a radius of 100 mi. The coal and all supplies will be carried to the plant by steamers docking directly at the property.

Another development is under way in New South Wales, where it is proposed to use a site on the Nymboida River for a hydroelectric power station. This development will give power and light to the cities of Grafton and South Grafton and will serve also a very wide country community. The total cost of the plant will be $175,000. Interest in further extensions of the electrical power facilities enjoyed by many cities of New Zealand is very much alive in that country, and during the beginning of the year meetings have been held in many parts of the islands. As the result, it has been decided to spend a further $36,000,000 in the North island and $29,000,000 in the South island for developing the extensive hydroelectric possibilities of New Zealand. More than $700,000 will be spent for planning, outlining and surveying the existing projects.

The North island hydroelectric scheme calls for the development of about 160,000 hp., at an estimated cost of $10,000,000 for the construction of the dams and the placing of the machinery at the power plants, $7,561,957 for the main transmission lines, $4,082,059 for the main substations, $10,151,519 for distribution lines and secondary substations and $3,711,344 for miscellaneous expenses pertaining to the work, making something less than $230 per horsepower for the total installation of the plant. This scheme proposes to connect three different plants quite widely separated, and from these stations to supply Wellington and vicinity and Auckland and vicinity, as well as intermediate cities and towns. It is expected that the Government will be able to supply the current at a very low rate as compared with the current from steam power.

The main transmission lines will be of the suspension type carried for the main on ironbark poles, though steel tower construction will have to be adopted in some cases where special construction is necessary. It is proposed to transmit the current from the central station at 100,000 v. and reduce it at the main substations to

11,000 v. to be distributed to the local substations and surrounding districts. The scheme provides for a total length of 1112 mi. of main transmission lines and 309 mi. of branch mains at lower voltage to supply disconnected main substations. The municipal governments at Wellington and Auckland, as well as most of the small cities intervening and even farther north are greatly interested in this development.

The South island scheme calls for an expenditure of about $30,000,000 for the purpose of further developing the Lake Coleridge power plant, together with the distributing lines, and a new hydroelectric system near the extreme south of the South island for the use of Dunedin, Invercargill and other centers in that part of the Dominion. The further development of the Lake Coleridge power plant is quite urgent, and beyond a doubt something will be done to increase its output within the next year or 18 mo.

After the execution of this scheme, New Zealand will have an almost perfect supply of electric power, covering the whole Dominion.

South American Activity

All reports from South America indicate a great activity in the power industry. Expansion, however, is still much hampered by the lack of foreign capital and the uncertainty about the supply of the necessary materials, which will have to come either from the United States or Europe. The Central of Brazil Railway contemplates the electrification of most of its suburban lines and part of the trunk line. The estimated cost is $4,300,000. A small hydroelectric plant is to be installed near Santa Maria in Colombia, using the water of the Rio Gaira. The total development will be only 450 hp.

Another of the German electrical enterprises in South America has been lost to the electrical industry of that country. The hydroelectric lighting and power plant of Guatamala City (Empresa Electrica de Guatemala) was a German institution, and more than 90 per cent of the stock was held by the Deutsche Bank of Berlin. By executive decree this property was in 1918 taken over by the Guatemala Alien Property Custodian, and by later decree was declared forfeited to the Guatemala Government and nationalized. This property has now been leased to Henry W. Catlin, of New York, for the term of 10 yr. at a cash rental of $40,000 per annum, together with the option of extending the lease for an additional like period. The government concession under which the old company operated has been extended for the life of the contract and any prorogation. The lessee also becomes the preferred bidder in any future sale of the property.

The plant was erected by the Siemens-Halske Co. (Berlin), with a present capacity of 2000 kw. at 4000 v., three-phase, alternating current, which is transmitted from the power station at Palin, 28 mi. distant from Guatemala City. The entire pole line, both transmission line and for city distribution, is made of 9 and 10-in. I-beams. Some 16,000 incandescent lamps, 280 open arc street lamps, and 2000 hp. in motors are served. The leasing company also acquired the right to an incompleted water power and central station at San Luis, about 6 mi. from the present operating station at Palin, which, when completed, will give an additional 3000 kw. The plant as it stands today has an estimated value of $1,000,000 and the cost of completing the auxiliary station is estimated at $300,000.

Power Developments in Japan

The electrical power industry has expanded rapidly during the war in Japan, and it seems that that country is again in the center of a power boom like that which came to grief several years ago, after the great increase in electric power financing following the Russo-Japanese war. At the end of the year 1918, $183,000,000 had been invested in power enterprises in Japan, excluding electric railroads. The total electrical investment was $371,000,000, or $32,000,000 more than 1917. As an investment field, the electric industry now stands second in Japan, giving way only to the railroad investment, which is $548,000,000. Japan is to build a large power station in Formosa at Jitsugetsu-tan in the Nato Prefetcure, Taiwan. The work will be begun during the present year. It is proposed to build a plant producing 130,000 hp., which will make it one of the largest hydroelectrical developments in the Asiatic East. The cost will be $24,000,000 and it may take five years to complete the work.

Unconsumed Fuel

By Mark Meredith

With gas or oil engines it is a comparatively easy matter to ascertain whether combustion is approximately complete, for the general behavior of the engine, and the character of the exhaust gases are indications enough that this is so. The question of the quantity of unconsumed, though consumable, material conveyed to the ash pit from a coal-fired boiler is unfortunately not quite so simple. If one examines carefully almost any ash heap, it will be possible to find a greater or less proportion of both raw coal and coke in various stages of consumption, to say nothing of the "riddlings" which are often thrown away with the ashes. This constitutes a serious waste and suggests a field wherein it may be possible to economize. A simple check can be kept where apparatus for analysis is available, by observing the actual percentage of ash sent out as compared with the theoretically incombustible content of the original fuel. It is, of course, never possible to bring the former down to the same figure as the latter; but by careful attention to the conditions under which combustion is carried out, the excess amount may be cut down appreciably. This unconsumed fuel also aggravates the problem of ash disposal, which is in itself a serious matter for numerous undertakings. In view of this it has been found possible to set fire to ash-heaps and thus reduce their bulk considerably, the combustion being a comparatively low-temperature process, and the residue comprising almost entirely the genuine incombustible according to the original chemical analysis. The cubic capacity by which the ashes are thus reduced in bulk may be considered a rough indication of the amount of combustible matter which had been wastefully deposited.

Powdered Fuel and Its Equipment

Methods of Preparation and Handling—Types of Pulverizers

WITH proper furnace and burning equipment, virtually any bituminous or semi-bituminous coal can be burned in pulverized form. Slack and silt may be used as successfully as screened or mine run coal, and require no preliminary crushing.

Coal in which the ash content is less than 10 per cent will commonly give the most satisfaction, the volatiles averaging between 30 and 40 per cent and the fixed carbon between 40 and 50 per cent. Low sulphur content is desirable, and the ash melting point should be high in order that the ash will be deposited as a dust rather than a slag.

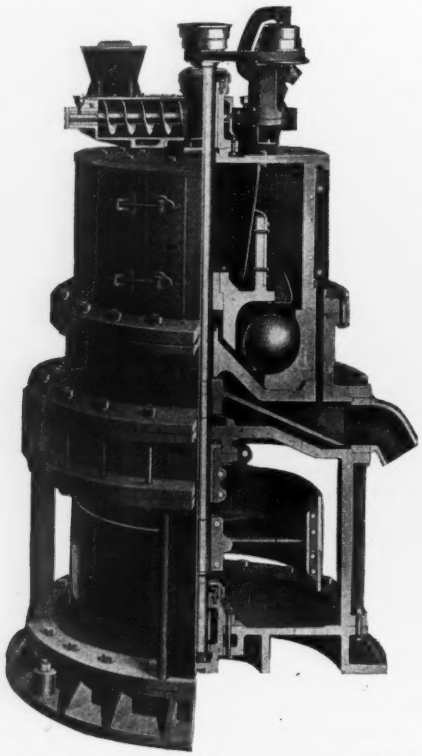


FIG. 1. PULVERIZER MILL WITH MOVING BALLS AND STATIONARY GRINDING RING

If raw peat is allowed to lie in heaps until natural drainage and evaporation have reduced the moisture content to about 50 per cent, it may be prepared for use under steam boilers by driving off about half of the remaining moisture with waste heat from flues and pulverizing the resulting material. According to E. A. Beals, of Hartford, Conn., who has been experimenting with this process, the powdered peat may then be blown with compressed air into the furnace, where by means of a forced draft, ignition is almost instantaneous, and instead of burning on the grate, the peat forms a gas which gives a uniform fire throughout the entire combustion chamber.

Peat powder may also be prepared for fuel by pulverizing machine peat blocks after they have been air dried to about 40 per cent of moisture and then screening and heating the material thus obtained in rotary driers until it contains about 15 per cent of moisture. This process, however, is so expensive that it is doubtful whether peat so prepared could successfully compete with powdered coal.

Equipment for employing pulverized coal is standard for any grade of coal as far as handling, preparing and delivering to the furnace is concerned. Only a slight change is necessary in the furnace to take care of coals of extremely low volatile content, and increased drying capacity is desirable when lignite or similar fuel is used.

Preparation of Powdered Fuel

Coal as received should be crushed so that it will pass through approximately a 1-in. ring. Usually a single roll coal crusher is employed. Drying to elimi-

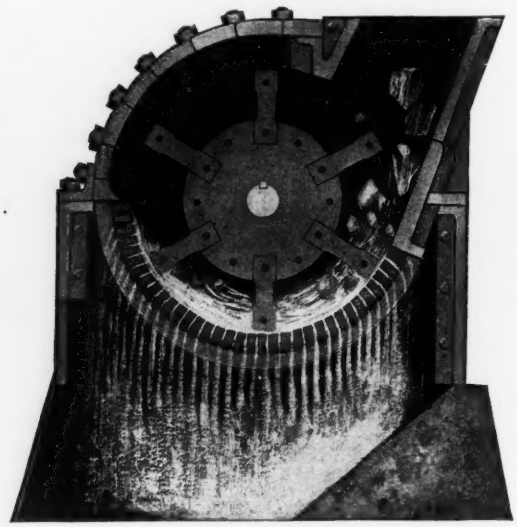


FIG. 2. SWING HAMMER PULVERIZER

nate moisture in excess of one per cent is the next process in order to facilitate pulverizing and prevent accumulations in the passages.

Compressed air appears to be most satisfactory atomizing agent for use with powdered coal. All air required for combustion may be compressed by turboblowers to a comparatively low pressure, heated by the waste gases, then released in a mixing chamber or burner designed to distribute the charge evenly in the furnace.

Equipment for grinding and drying should be placed between the boiler plant and coal in storage. The quantity of waste gases to be diverted to the drying plant will depend upon their temperature and the moisture content of the coal. One of the best performances known is 4 to 5 lb. of water evaporated per pound of coal used in the drier; in certain plants the ratio is nearer unity. Therefore, with coals running high in moisture a material saving will be possible by the use of waste gases in the drier.

Driers are commonly of the rotary type, the coal being fed into an inclined shell mounted on rollers, and

passing through the drier by gravity. The drier should be so arranged that the combustion gases coming from the furnace do not come in contact with the coal being dried until their temperature is reduced sufficiently to prevent ignition. To prevent a decrease of its heat value, the temperature of the coal being dried should just be high enough to drive off the moisture.

To remove any stray iron or steel which may have accumulated in the coal, a magnetic separator of some approved make is installed either before the crusher or after the drier. This elimination improves the pulverizing and conveying operation, and prevents wear and tear on the machinery.

As it passes through a modern pulverizing plant, the coal should be conveyed in dust-tight equipment. After crushing it is next elevated to bins above the driers. These bins should be of sufficient size and provided with a variable speed feeding device, to insure uniform feed at all times. This is important in order that the moisture content may be reduced uniformly and permit close furnace regulation. In well-designed plants, the dust-proof conveying and storage system is ventilated to prevent as far as possible, recondensation of moisture released by the heat of grinding.

Leaving the drier, the coal is elevated and discharged into storage bins above the pulverizer. All storage bins should be large enough to prevent running empty.

Coal should be pulverized so that 95 per cent will pass through a 100-mesh sieve or 85 per cent through a 200-mesh sieve. This has been commonly adopted as a practicable commercial standard. The finer the coal is pulverized, the more readily it will be diffused when mixed with air for combustion, and the more efficiently it can be burned. Pulverized so that 95 per cent passes through a 100-mesh sieve, a cubic inch of coal will contain about two hundred million particles with an increase of superficial area of approximately 700 times.

Pulverizing Mills

In the pulverizer mill shown in Fig. 1, the coal is fed from an overhead bin by means of a feeder mounted on top of the mill. This feeder is directly operated from the mill shaft by means of a belt running on a pair of three step cones, which permit operative adjustment. To increase or decrease the amount of coal entering the feeder hopper, the hopper is provided with a slide.

Upon entering the pulverizing section of the mill, the coal is ground by four unattached steel balls which roll in a stationary horizontal concave-shaped grinding ring. These balls are propelled around the ring by means of four pushers attached to equidistant horizontal arms forming a portion of the yoke, which is keyed direct to the mill shaft.

Those mills operating with fan discharges are equipped with two fans. One fan is connected in the separating chamber immediately above the pulverizing zone and lifts the fine particles of coal into the chamber above the grinding zone, where the particles are held in suspension. The other fan operates in a housing immediately below the pulverizing zone and acts as an exhauster, drawing the finely divided particles through the finishing screen, which completely encircles the separating chamber. Leaving the separating chamber, the coal is drawn into the lower fan housing from which it is discharged.

In operation, the mill handles only a limited amount of coal at any one time. As soon as the coal is reduced to the desired fineness, it is lifted out of the pulverizing section and discharged.

To insure steady operation, every mill should be provided with a storage bin with a capacity of not less than four to six times the hourly capacity of the mill. To permit the coal to flow from the bin to the feeder hopper, each bin should have a feed pipe, 6 or 8 in. in diameter. This feed pipe or chute should be equipped with a gate or cut-out slide, placed close to the bin, to control the flow.

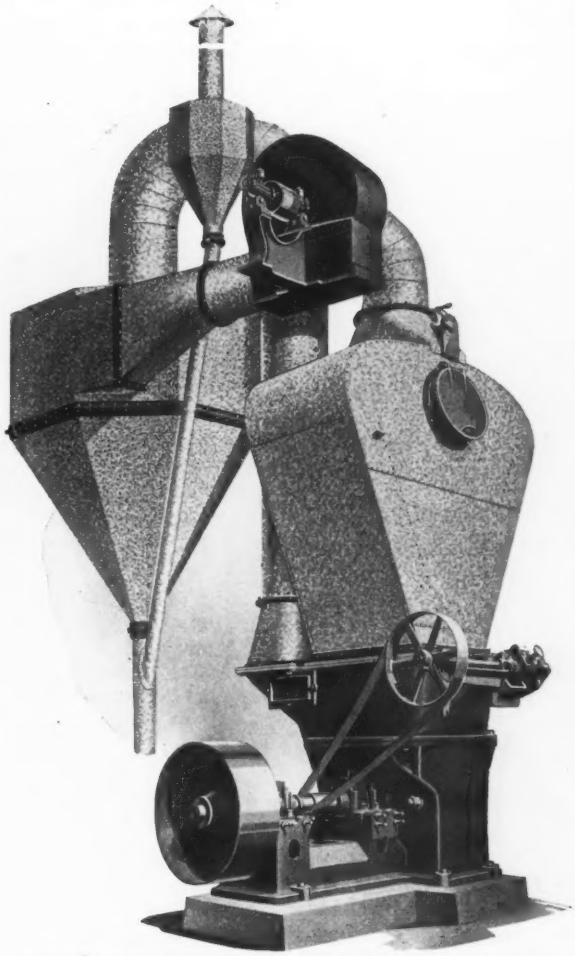


FIG. 3. PULVERIZER WITH VERTICAL GRINDING RING

To afford the operator easy access to the feeder, a platform having the floor about 3 in. below the top flange of the intermediate section, should be provided around the mill. As a small volume of air is discharged with the finely powdered coal, an air chamber should be provided, in the connection with the conveyor handling the discharged coal, to allow its escape. The size of the air chamber will depend upon the size and number of mills discharging into the conveyor. Ordinarily, the chamber should be proportioned so that an area of cross section of 1 sq. ft. is supplied for a 33-in. mill and of 1,5 sq. ft. for a 42-in. mill.

In recent years the swing hammer pulverizer has demonstrated its ability as an efficient machine for coal pulverizing. Such a type is shown in Fig. 2. This machine pulverizes the coal by striking it while in suspension.

Coal is fed in near the top of the machine, and in falling comes in contact with rapidly revolving hammers, which force the coal against the breaker plates, from which it rebounds again into the paths of the hammers. As the fineness is largely determined by the intensity of the blow, the varying degrees of reduction are obtained by varying the speed of the machine.

Another type of pulverizer, Fig. 3, consists of a heavy one-piece main frame, which contains the grinding elements, consisting of grinding rolls and roll head

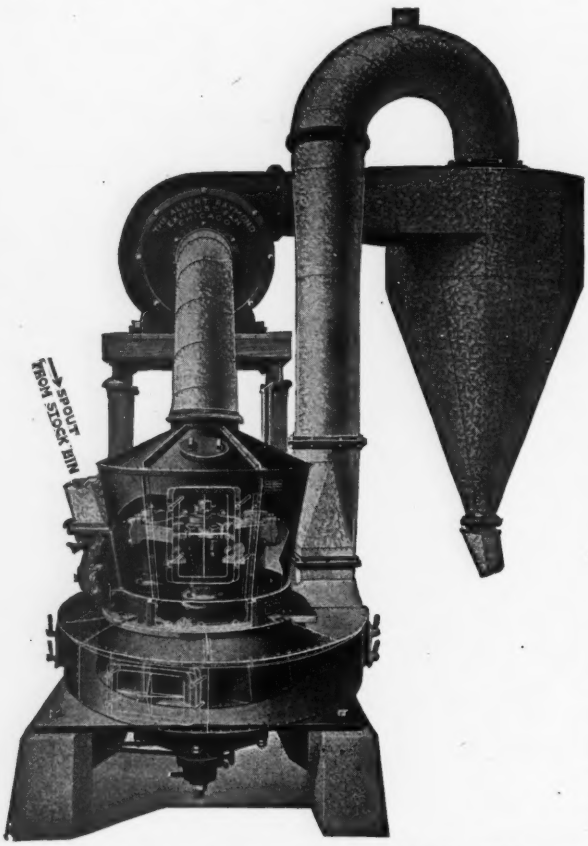


FIG. 4. CROSS SECTION OF FOUR-ROLLER MILL

or driver. The main frame is lined with a removable steel bushing to form a seat for the grinding ring. This grinding ring stands upright and is held in place by two large clamp bolts extending through to the rear of the base. Revolving around the inner side of the ring, the rolls are held in place and driven by the recessed driver, which is so shaped as to converge the coal on the track of the rolls.

This pulverizer is claimed to be favorably adapted for use with a separator, as the grinding parts revolve in a vertical plane, throwing upward a constant stream of pulverized fuel.

Entering at the bottom of the separator, the air current passes upward and carries off fine material. Because of the increased area toward the top of the separator, the velocity of the air current is reduced. This permits the coarser particles to fall back into the grinding chamber, while the finer material is carried upward.

An interior flue is provided on each side of this separator, by means of which a considerable range of fineness may be secured. These flues are hinged at the bottom and adjusted by a lever outside the separator. To obtain a fine product, the flues are inclined outward to a position parallel with the walls of the separator; for obtaining a coarse product, they are set in a vertical position. The air current carrying the extremely fine material passes from the separator through a pipe to the collector, entering horizontally on the side.

As the collector is polygonal in form, the faces break up and change the direction of the air current, meanwhile reducing the velocity. This permits the material in suspension to drop to the discharge pipe at the bottom of the collector. At the top, a connection leads to a small auxiliary collector, designed to remove any moderately fine particles still in suspension.

Gravity and centrifugal force are the pulverizing mediums of the mill shown in Fig. 4. Material is fed to the mill through the spout into the automatic feeding mechanism, the quantity of material being regulated by varying the speed of the feed roll. In the grinding chamber it is caught by the manganese steel plows and thrown up between the rollers and the pulverizing ball ring. One of these plows is located just ahead of each roller to force a constant stream of material between the rolls and the ring.

Separation of the finely ground material from the coarser particles is accomplished by a constant stream of air drawn through the mill by the exhaust fan placed above it. This air enters the mill through a series of tangential openings around the base of the grinding chamber and passes upward around the rollers and ball ring. In its passage it carries with it the finely pulverized material from the grinding chamber into a separator. Coarser particles fall back and are thrown up by the plows to be reground until reduced to the required fineness.

Designed to use a metallic grinding medium is the mill shown in Fig. 5. It is of tubular construction with two compartments, the division head having holes through which the fuel may be transferred. The small preliminary grinding compartment is charged with forged steel balls varying in sizes from 5 to 4 in. diameter down to 2½ in. In the larger finishing compartment are special white alloy cast-iron balls presenting both a concave and convex surface. Their advantage over the special bodies consists in the securing of a greater contact surface.

From Pulverizer to Burner

Methods of handling the coal from the pulverizer to the burner are dependent upon the distance of travel and the quantity carried per hour. Screw conveyors are commonly employed in plants where the daily capacity is from 50 tons upwards. Carrying the powdered coal in suspension is another method, but the power required to furnish the air is much greater than that required for operating a screw conveyor. Compressed air is also employed to propel the fuel which is admitted to the pipe in charges.

Feeders for regulating the flow of pulverized coal to the furnaces must be designed so that the variation in quantity will at all times be directly proportional to the speed of the screw. Speed of the feeder should be regulated so that at the maximum speed the supply will not exceed the furnace capacity.

Boilers of virtually any type or size can readily be arranged for pulverized coal firing, but those containing the smallest percentage of space for the lodgment of ash are preferable. Soot blowers should be installed in all settings. Where possible, vertical baffles should replace all horizontal baffles.

The combustion chamber should be sufficiently large in order that the flame may occupy approximately four times the volume of one produced by an ordinary grate fire. Freedom from metallic cooling surface, which stifles the flame and hinders combustion is essential. For this reason, the reverberating furnace is well adapted to powdered coal. In all cases, the fuel must be projected into a chamber sufficiently hot to cause instant burning. Surface velocity of the gases is one of the important factors influencing the proportioning of

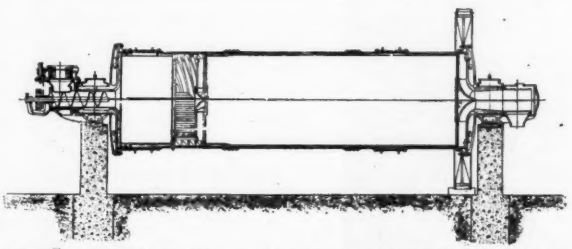


FIG. 5. TUBULAR MILL CHARGED WITH GRINDING BALLS

furnaces. High velocities create erosion, and erosion means destruction of the refractory lining. Thus, the size of the furnace.

Burners

Furnaces employing pulverized coal should have as few burners as is consistent with good regulation, for it has been found more desirable to introduce pulverized coal into a furnace as far away as possible from the refractory lining or side walls in order that the rapid continuous expansion of the gases will not develop excessively high velocities.

Burners must be proportioned for the maximum setting of the boiler, and should be adjustable. They are commonly designed with a variable-speed screw conveyor, which drops the coal into a blast of air. As powdered coal frequently tends to flow along the conveyor ahead of the screw, the screw is usually made quite long to add sufficient friction to prevent flushing.

Pockets or storage spaces are avoided in good burner designs. Burners should be located away from the influence of furnace heat, which may cause the formation of coke and prevent smooth operation.

The federal trade information service states that, according to information furnished by Secretary of Industry and Commerce of Mexico, the potential production of oil wells now in existence in Mexico is the equivalent of 1,592,649.14 bbl. daily. Actual production is 27,801,610 cu. m., or 174,872.12 bbl., equal to 10.98 per cent of potential output.

Training for Combustion Engineers

Efforts of the Fuel Administration during the war to conserve fuel by their splendidly organized appeal for greater plant efficiency are bearing fruit in many ways. There is great interest in the subject of "combustion efficiency" and a growing dissatisfaction with the old indifference to what are now recognized as unnecessary wastes in the boiler room. Everyone recognizes that such conditions were not due primarily to any fault of the men operating the plants. High standards of boiler efficiency were comparatively a new thing. Boiler rooms, as a rule, were neglected and attention given the engine room operation to the detriment of the boiler room.

Gradually, during recent years, through the efforts of consulting engineers and certain pioneers in the combustion field, standards of efficient boiler room practice have crystallized so that principles are as well understood and methods as clearly defined as at the other end of the steam plant. It is seen that the subject of combustion must be studied and mastered by itself; that there is a place for the combustion engineer just as for the steam engineer; that, in fact, every steam engineer should be a combustion engineer.

The principal reason that there have been so few combustion engineers has been the lack of adequate courses of training, the subject having been handled only as part of courses in steam engineering.

The demand for a training in combustion engineering has been recognized by Joseph W. Hays, who has frequently written articles for Power Plant Engineering. He has prepared a course whose purpose is to give a complete training in combustion efficiency through the mails and to graduate combustion engineers from the ranks of steam engineers and boiler room men, who can do the necessary reading without interfering with their regular work.

The Hays course also lays stress on the possibility of advancement for any young man who is not afraid to tackle the disagreeable features of the job of firemen, taking up at the same time the correspondence course in combustion. The boiler room is the best place for him to apply and work out what he learns along combustion lines, and when he is graduated as a combustion engineer, he has a fine outlook ahead to pay him for the apprenticeship he serves shoveling coal and wheeling ashes.

Mr. Hays has associated with him, as reviewing and advisory editors, some of the best talent among combustion men in the country, who have contributed their services to the course for the good of the cause. The names of Joseph Harrington, Fred R. Low, David Moffat Myers, Professor S. W. Parr and Arthur L. Rice would seem to ensure a high standard of teaching.

There was a plant manager who went mad at mention of the Rights of Labor, and who "fired" every employe who presumed to suggest a "raise." By and by his plant was filled with cheap labor, which surprisingly cut the item of wages. But one day some boiler tubes burst and scalded several firemen, and a generator burnt out and crippled the plant. Then the whole plant loafed while the manager went begging for skilled mechanics to repair the damage.

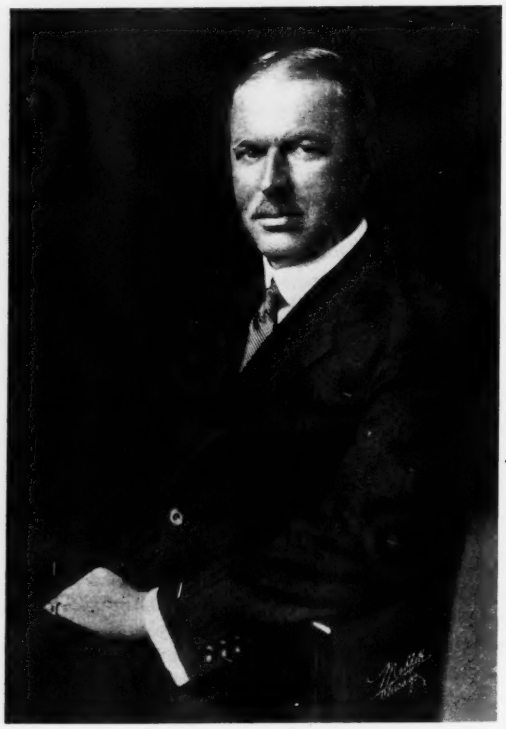
P. ALBERT POPPENHUSEN

POPULAR ENGINEERING EXECUTIVE AND KEEN SPORTSMAN A FACTOR IN THE DEVELOPMENT OF THE CHAIN GRATE STOKER. BY WALTER PAINTER

AMONG NOTABLE examples of engineering executives, whose powers of adaptation, organization and personality have bridged the gap to success, are those who possess great ability to recognize and utilize an opportunity. They have seized the lamp of leadership to guide an idea to a successful end, to expand a wee opportunity into a huge factory covering acres of ground.

Ask prominent power plant men who is the most popularly known machinery salesman in the country—their reply is apt to be, "Pop," and he is one of the notable examples.

P. Albert Poppenhusen was born 45 yr. ago at College Point, L. I. His grandfather, Conrad Poppenhusen, was organizer and builder of the Long Island R. R. His parents recognized early his inherent ability—he was tutored until the age of nine, then attended school abroad for six years. In 1889, he returned and completed his studies at Northwestern University, Evanston, Illinois, where his parents had moved in 1885.



In 1897, with his brother Herman, a graduate of Boston Tech., he organized the Green Engineering Co., which acted as western representative for four large manufacturers and handled the sales of boilers, economizers, heaters and high speed engines. In this capacity his knowledge of power plant requirements expanded rapidly. He was studious and alert; his ability to foresee and anticipate the needs of smooth, efficient steam generation, and his happy balance of creative and constructive faculties brought forth successful results.

At the Chicago World's Fair, he had become permanently interested in combustion equipment. Several British manufacturers had exhibited the early types of automatic stokers. Mr. Poppenhusen was instrumental in the development of an improved type and subsequently his company concentrated upon large-scale production of the chain grate stoker. Until 1901 he served as secretary and treasurer, but has been president ever since. He has always maintained that the stoker industry was distinctly an engineering profession rather than a foundry job. Conditions of service influencing the successful operation of his machinery have been his deep study. He has also been active in the development and introduction of pressure water backs, and pneumatic and steam jet ash conveyors.

He is president of the Stoker Manufacturers' Association, and serving as chairman of its War Service Committee, unselfishly contributed much of his time in Washington during the war period, consulting with the Fuel Administration and War Industries Board.

Hobby? Hunting and fishing—but particularly big game hunting. He has tracked game from New Foundland to British Columbia and killed everything that wears horns. Four to six weeks each year he is a forest dweller and trail traveler, subject to all allurements of the open. Arranged upon the walls of his office are superb specimens of his skill—caribou, elk, mountain goat, sheep and deer and photos of his mountain camps. He is a frequent contributor to outdoor sportsmen's publications, an enthusiastic member of the Adventurers' Club, Caughnowona Fish and Hunting Club, and Camp Fire of America Club. His wife is an enthusiastic huntress.

As a member of the leading athletic and country clubs of Chicago and New York, the American Society of Mechanical Engineers, Western Society of Engineers, Knights Templar and Shriner, his friendly associations are widespread. Each time Mr. Poppenhusen meets a man, one more friend is added to the list. His geniality makes friends, his integrity keeps them.

Management and Training of Men*

KNOWLEDGE OF HUMAN NATURE IS REQUIRED. VOCATIONAL TRAINING. BY W. W. GIDLEY

NO FACTOR in the industrial world today presents to the employer a problem of such extreme complexity as the training and managing of men. It has been proven repeatedly that wholesale discharging by those in authority, in order to procure the right man for the place, is a dismal failure. It is therefore expedient that a system be developed whereby this weakness may be properly analyzed and a correct solution applied.

The time has arrived when men who supervise labor must know the meaning of morale and how it is developed. The heads of various departments in any industry must be interested in safety, efficiency, and democracy, and understand how these features may be linked together with proper discipline.

MANAGEMENT

EVERY industrial organization should have its rules. These rules should be formed with utmost care and consultation. A few plain rules steadily enforced will be worth more than the most minute attention to trivial details. These rules should be the expression of the united will of the industrial executives. They should, however, as far as possible, be such as would commend themselves to the employe and convince him that they are based on fairness and mutual principles. The moment the employe suspects deception on the part of the foreman, the authority of the latter is weakened and the respect of the worker is impaired. It is absolutely necessary that in every case the worker should thoroughly understand the reason for the rules governing the conditions under which he is employed; thus confidence in decisions by those in authority will be greatly strengthened by perceiving the propriety of these rules. This will enlist both reason and conscience on both sides and create mutual understanding.

The execution of rules is another problem. It is here that failures are most frequent and disastrous. The cause of these failures will be more fully presented when we speak of the mistakes usually committed in management. The rules of industry should be enforced gently and yet with inflexible firmness. Here there should be an absolute oneness in the governing organization. If the foreman of any department shield employes under his supervision from certain penalties for violating the rules of the organization, he creates a tendency that will be surely practiced on himself with redoubled effect. The grand agent in executing rules is mutuality. This, to be properly effective, should manifest itself in words and actions. The boss whose repulsive attitude represses all interest of the worker not only misrepresents his employer, but builds a wall between himself and his men which cannot be penetrated. One great mistake in management of men is that the boss is prone to censure but fails to commend them when work well-performed merits approval. As long as the nature of man remains what it is, it will demand reward for faithful service. It is not necessary or proper to show favoritism to any particular employe, but simply to enable him to feel that the path of his daily vocation is not entirely obstructed with dissension.

Partiality is a very great error in the management of men and one that deserves specially to be guarded against, for it injures alike the favored and the slighted employe and the former more often than the latter. But to treat all dispositions alike is equally erroneous. There are marked differences of character in manhood. Some natures are constitutionally tractable, others the reverse, and to treat both alike would be like trying to work wax and iron in the same manner. The first duty of the boss then is to study the character of the man and adapt his discipline to that character, in order that he may receive the training his respective nature demands.

Constant fault-finding is another common error and is pernicious. There are many minor faults in men that are like the branches and sprays of a large bough, all of which will be removed by the removal of the main stem. To be continually carping at these secondary faults, while the primary causes are neglected, only tends to disorganize and disinterest the employe. Instruction demands many words, management but a few; and these few closely connected with prompt, decisive acts, or they will be mere empty air.

TRAINING

THE PRESENT phase of industrial development demands that the supervision of men requires the faculty of training ability, consequently all executives, regardless of the magnitude of their sphere of duties, are called to study and practice this important science. Like all other sciences, the science of vocational training rests on truths and facts. Most of these are now understood and established. A wise executive cannot safely overlook them.

Man's character or disposition is the commanding faculty or power of his nature, controlling and directing every other power. It is this faculty that needs to be educated; indeed, on account of its importance, it requires the most special and careful training. It is of great importance to educate all the faculties; the memory, the reason, and the imagination; that is, these should be educed, drawn out, exercised, trained, and disciplined. But the first and greatest study should be character, the master-faculty, on the proper action of which depends the successful training of all the rest. The greatest difficulty in training men is experienced with that class whose nature is disposed to perverseness or intractability and inclined to independence and excessive self-gratification. The character of such men stands in need of correction as well as direction.

In industry, particularly where extreme hazards are involved, those having supervision of labor hold a most important position. They must assume not only the responsibility of training men but must also act as guardian and protector over the less experienced. Far more depends on the proper training of men in industry than

*Abstract of paper read before the Eighth Annual Safety Congress of the National Safety Council.

is ordinarily supposed. Their correction and guidance is a duty that admits of no argument. It is simple justice. How important then, that extreme care be exercised in training men in safe and efficient methods. It is quite true that there can be no successful vocational education where the worker is not subordinated to the right rules and governed by wise proper motives. No employe can control himself and apply his body or mind to any given work unless he has received the necessary training to develop his fitness for any given vocation.

The result of vocational training upon the worker in the industries lies in convincing him that real efficiency reflects and conserves the human element, that it increases his earning power, that the primary or essential principle is conservation, and that it develops his power to utilize his natural resources previously neglected.

Many industrial plants throughout the country have established and maintain departments for vocational study and are doing much to encourage the worker to take advantage of this opportunity. It has also been considered by nearly all leading educational institutions where much is accomplished for the advancement of this important work. Widespread vocational training is absolutely essential before we can hope to achieve that industrial standard for which capital and labor must collectively strive to promote and perfect mutual interests.

In the course of the present trend of advancement in the industrial world, the fact with which we must reckon is, that however we may act, industry is a school, and vocational education is taking place whether we direct it or not. We may neglect our part but the education will go on. How important, then, that those engaged in training men in the various branches of industry should realize the significance of their duties and see to it that men are directed in the proper channels for the up-building and increased earning power of the worker, and for the advancement of industry in our country in order that we may be at par with other countries of the world, and above all for the safe-guarding of life and limb.

To be successful in educating the employe, the teacher must of necessity be a student himself. He may possess all the qualifications to direct and promote efficient methods but must reckon with the human element. He must assume the task of patiently seeking to develop all the faculties, which requires constant study of the master-faculty, "Human Nature."

Why Concrete Stacks Are Successful

PROPERTIES OF CONCRETE WHICH RENDER MATERIAL CAPABLE OF WITHSTANDING EXACTING SERVICE. BY A. C. IRWIN

BUILDING materials have inherent qualities that mark them as suitable or unsuitable for certain specific purposes. In many cases the purpose to be served is at such variance with the nature of the material that it is at once recognized that it cannot be used, while for other specific purposes more than one kind of material possesses more or less satisfactory qualities. Obviously, combustible material cannot be used where subjected to fire such as in the lining of kilns, furnaces, flues and chimneys. Nor can materials or combinations of them having little or no strength be required to carry loads. These statements are so elementary and self-evident that their enunciation seems meaningless; but on reflection, we see that between those cases that are self-evident as to the nature of the material that must be used there is a gradation up to the fireproof type of structure wherein there are but a few kinds of building materials that can be used at all. The question then requires a decision as between the several kinds of material that can be used and those which are best suited. A number of well known building materials satisfy the condition of being incombustible in themselves, but combined with this requirement of incombustibility there goes for many structures the requirement that the material be able to withstand certain loads and that it be able to stand both tension and compression. This is the case with chimneys.

Chimneys are constructed of steel, brick, clay tile and concrete, all of which are classed as incombustible. As a general proposition, therefore, the selection between them must hinge on some other quality. Stacks are required to withstand wind stresses which tend to break them off at any point in their height and, unless the chimney is heavy enough to overbalance complete the overturning effect of the wind, tension will be produced on the windward side. Of the materials mentioned there are but two that have any considerable ability to withstand tension stresses. These are steel and reinforced concrete. In fact, although plain concrete is able to withstand a considerable amount of tension, the concrete stack gains most of its ability to resist such stresses through the action of steel rods embedded in it. Thus we see that reinforced concrete satisfies not only the requirement of incombustibility of the material but also affords that structural strength that is necessary for economy in a tall chimney.

In deciding on the type of chimney to build the engineer should keep in mind these fundamental things on which a correct judgment must be based as well as having available the experience of others in the use of the sort of structure he contemplates building.

The writer has recently conducted an investigation of concrete chimneys doing duty in plants of all descriptions, including smelters and industrial works which subject chimneys to hard usage. This investigation shows that of 251 owners reporting there is not a single case of total failure, and satisfaction is indicated in every case. That concrete is a suitable material for any purposes where it is subject to attacks of heat, products of combustion or undiluted acids is proven by these and many other similar examples. Furthermore, concrete has been used successfully for lining kilns and in numerous cases ordinary concrete, that is without especially chosen aggregate, has withstood without injury temperatures up to 1500 deg. F. As a rule, however, for such high temperatures and higher, a specially selected aggregate should be used such as broken fire brick or cement clinker. Chimneys that must withstand especially high

temperatures are given a lining either of fire brick or of concrete, using a specially selected fire-resisting aggregate.

As to the effect of products of combustion and undiluted acids, this question must be treated from both a physical and theoretical angle. It is known that practically all kinds of fuel emit gases which contain more or less oxidized sulphur, but while the plant is operating they pass out of the chimney in a hot and dry state. Only upon shutting down the plant, is there any possibility of liquid acids being formed on the stack walls and then only of a dilute nature. Investigations of properly constructed chimneys at zinc and copper smelting plants indicate that no effect is noticeable even after years of constant and hard service. The fundamental requirement for such cases is a dense, impervious interior surface, which under extremely unfavorable conditions may be given a special coating that is proof against the particular gases handled.

THE HIGHEST CONCRETE CHIMNEY IN THE WORLD, LOCATED AT SAGANOSEKI, JAPAN

It has been argued without knowledge of the facts that the walls of concrete stacks permit rapid radiation of heat because they are thin. The fact is that "thin" as used in this connection, is relative. Concrete stack walls are not thin. It is true that they are thinner than ordinary brick stack walls but this is because the concrete is reinforced so that the entire stack becomes a monolith, able to withstand tension resulting from wind pressure tending to overturn it. The thickness is governed by actual engineering design to take care of wind stresses in combination with the actual weight of the stack. The result is an economical thickness of wall; but when we say that a 12 or 15-in. solid concrete wall is thin, we must be comparing it with something that is very thick and uneconomical. It is a well-known fact to all those who are at all familiar with the physical qualities of concrete that it is a very poor conductor of heat. It is not claimed that concrete is especially high in insulating value, but consideration of the truth only is necessary to acknowledgment of the fact that the thickness of concrete stack walls, together with the low heat conductivity of concrete is sufficient to prevent any considerable heat loss. Actual experience with hundreds of stacks bears this out.

Furthermore, it is the practice of some concrete chimney builders who have had years of experience with such stacks, and who have made special studies of all the conditions to be met, to line all chimneys on the inside with a secondary shell of concrete or other fire-resistive material for all or a portion of the stack height. This lining does two things: It takes care of those extreme cases where highly active and concentrated acid fumes are condensed on the stack walls, as above referred to, and provides additional insulation. The inner concrete shell or lining is not in contact with the outer or structural shell and a dead air space is formed, which affords a high degree of insulation. If the stack is lined with fire brick, the thickness of the brick lining is added to that of the concrete for prevention of heat losses.

Depreciation of Steam Plant

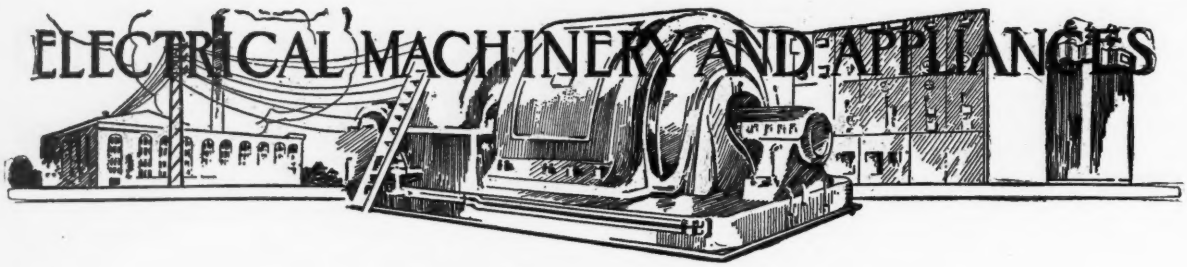
By Mark Meredith

IT IS impossible to establish a hard and fast basis for depreciation of a power plant, but the following concisely presents the average conditions:

With good water and good care, running about 12 hr. a day, life of a boiler should be about 20 yr., or the depreciation 5 per cent a year. Low-speed engines, running 10 hr. a day, can be estimated as having a life of about 25 yr., or a depreciation of 4 per cent a year. High-speed engines are much shorter lived, and will not average over 16 yr., or a depreciation of about 7 per cent a year, and oftentimes greater. The depreciation on boilers and engines when run 20 to 24 hr. a day is rather more than correspondingly greater. Boiler settings and piping should be included with the boilers, and engine foundations and piping with the engine.

The life of economizers varies with the initial temperature of the entering water, from about 10 yr. up to 40 yr.

Thirty thousand trained artisans are prepared to leave Germany for Mexico.



Alternating-Current Regulators---IV

THEORY AND CONSTRUCTION OF THE TIRRILL REGULATOR. BY V. E. JOHNSON

LOOKING NOW at the regulator as a whole we may analyze it as follows:

A. c. regulator comprises:

D. c. regulator on exciter

A. A vibrating switch short-circuiting, when closed, the exciter field rheostat, and controlled by

B. An element which maintains a predetermined exciter voltage by controlling the vibration rates.

A. c. regulator controlling the d. c. element

C. A voltage controlled element which responds to variation in the bus voltage, and which controls the action of the d. c. element

D. A compensating device designed to vary voltage with changes of load.

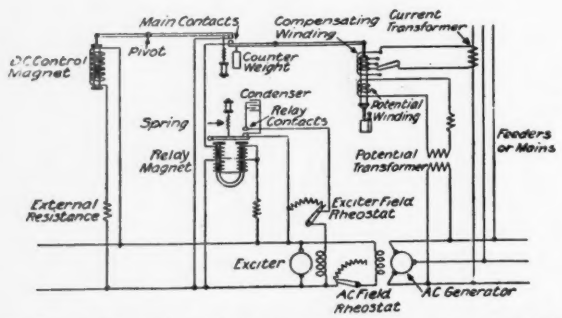


FIG. 9. ELEMENTARY CONNECTIONS OF A TIRRILL REGULATOR

In Fig. 9 we have shown schematically the connections of a Tirrill regulator.

Referred to the above general outline, the various parts are as follows: Part A consists of main contacts, relay contacts, relay magnets, relay spring and condenser; Part B consists of the d. c. control magnet and plunger, spring pulling downward on right end of d. c. lever and main contacts; Part C consists of the potential winding and plunger with dashpot, a. c. pivoted lever and its counter weight; part D consists of compensating winding and its dial switches.

The main contacts are part of both A and B.

Neglecting the action of the a. c. element of the regulator shown in Fig. 9 and assuming instead that the lever and its contact are stationary—the opposition of the d. c. element may be described as follows:

The exciter field rheostat is turned in so as to reduce exciter voltage considerably below normal. The spring having been previously adjusted so that the main contacts just close at "normal voltage" on the exciter, the result of this rheostat manipulation is that these contacts close firmly and in so doing energize the upper coils on the relay magnet. These upper coils are so connected as to oppose the action of the lower relay coils which are permanently connected across the exciter mains, and which tend to hold the relay contact open against the action of the relay spring. In other words,

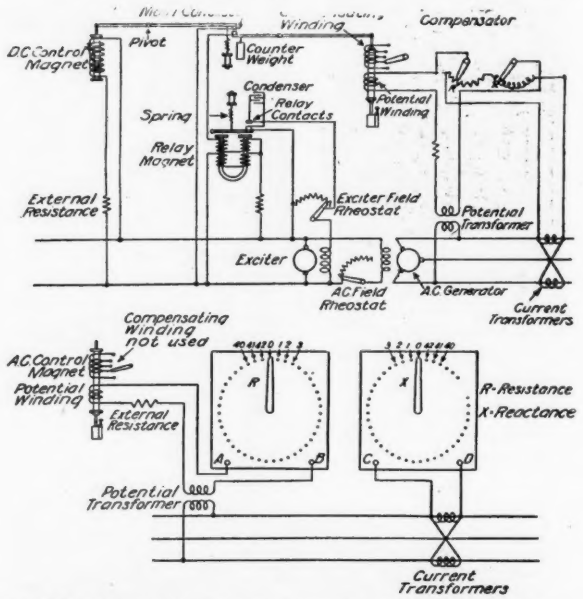


FIG. 10. CONNECTIONS OF VOLTAGE REGULATOR FOR A. C. GENERATOR USING LINE DROP COMPENSATOR

the closing of the main contacts results in the closing of the relay contacts through a process of demagnetization.

Closing the relay contacts short-circuits the exciter field rheostat and causes the voltage to rise rapidly along some voltage time curve as that of B, Fig. 6. The rising voltage causes an increase of downward pull in the d. c. magnet—and overcomes the opposing spring tension as the voltage rises above normal. The main contacts immediately open the circuit through the upper relay coils, and the relay armature under the influence of the now un-neutralized lower coils moves down against the

pull of the relay spring and opens the short circuit across the exciter field rheostat. This action is followed by a dropping of exciter voltage, resulting as before in the closing of the relay contacts. This cycle of operation continues and produces the effect of the vibrating switch already discussed.

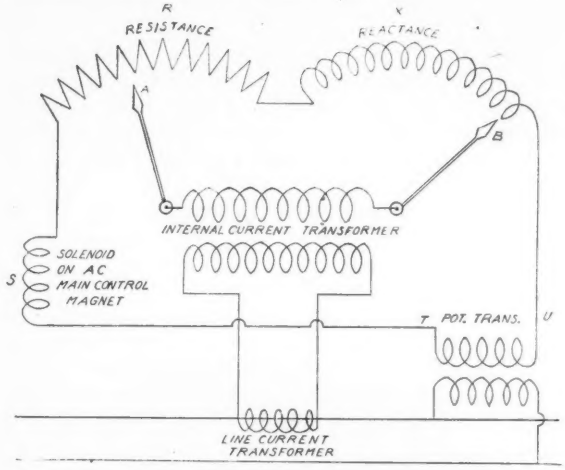


FIG. 11. INTERNAL COMPENSATOR CONNECTIONS

Under the foregoing conditions, the exciter voltage will fluctuate rapidly, and maintain an average value depending on the ratio of "closed time" to "open time." This average value must be that just required to balance the d. c. magnet pull against the spring tension, when

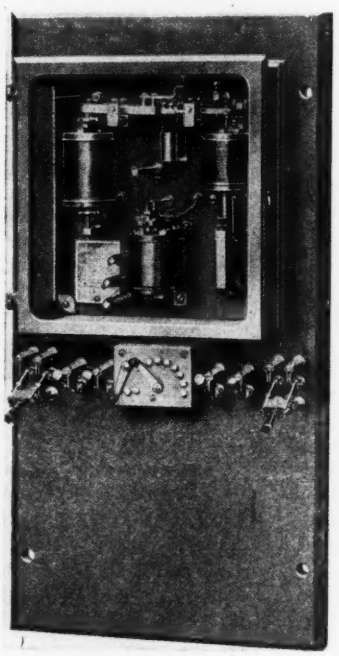


FIG. 12. A TYPICAL TIRRILL REGULATOR

the d. c. lever just closes the main contacts. If the average value is greater than that which will just balance the spring tension in the contact position, the d. c. magnet will pull its plunger down and permanently open the main contacts. This condition would occur in actual service if the exciter rheostat were turned "out" until "open switch" position would still be above normal.

If the average value is less than that which will just balance the spring tension in the contact position, the spring will close the main contacts permanently. This condition would occur in actual service if the full field voltage of the exciter due to overload, underspeed or misapplication were too low to open the main contacts.

As long as average voltage is maintained between "full field" and "open switch" as limiting conditions, the relay will under the influence of the main contacts, continue in vibration. From the curves in Fig. 1 it can be seen that the action will become sluggish near these limiting conditions but vibration must continue as long as the extreme points are not reached.

Effect of Adjustments

If by means of the screw adjustment, the spring tension be increased, the result will be that the average magnetic pull (or what corresponds to this—the aver-

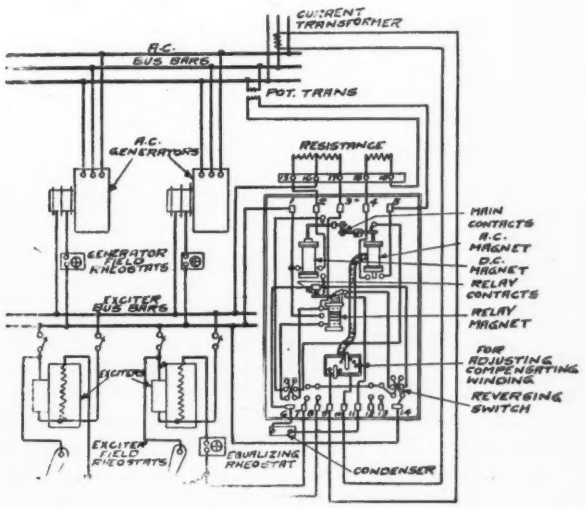


FIG. 13. DIAGRAM OF CONNECTIONS OF A TYPICAL TIRRILL REGULATOR

age exciter voltage) must be increased, in order to maintain vibration. The only variable in the combination as considered is the ratio of "closed time" to "open time"—and this must, as a consequence, increase. In other words, increasing the spring tension raises the exciter voltage by increasing the ratio of "closed" to "open." Similarly it follows that decreasing the spring tension lowers the exciter voltage by decreasing the ratio of "closed time" to "open time."

Going now a step further, it may logically be assumed that within reasonable limits, a movement upward of the lower main contact would have the same effect as tightening or increasing the spring tension, inasmuch as it would require an increased average downward pull of the magnet to maintain vibration. In other words, we may say that a movement upward of the lower main contact will increase the exciter voltage by increasing the ratio of "time closed" to "time open." Similarly it follows that a movement downward of the

lower main contact decreases the exciter voltage by decreasing the ratio of "time closed" to "time open."

Action of the a.c. element consisting of the apparatus tabulated under C and D above is comparatively simple. Essentially this portion of the regulator consists of a solenoid energized from the a.c. circuit to be controlled, a plunger suspended in this solenoid and attached to the a.c. control lever shown in the sketch, a counterweight and a dashpot. The a.c. lever bears on its left end the lower main contact.

This mechanism is in equilibrium when: effective pull of plunger = effective pull of counterweight + effective upward pull of magnet. From this equation it is obvious that it is possible to balance any magnetic pull within the limits of the apparatus by varying the value of the counterweight.

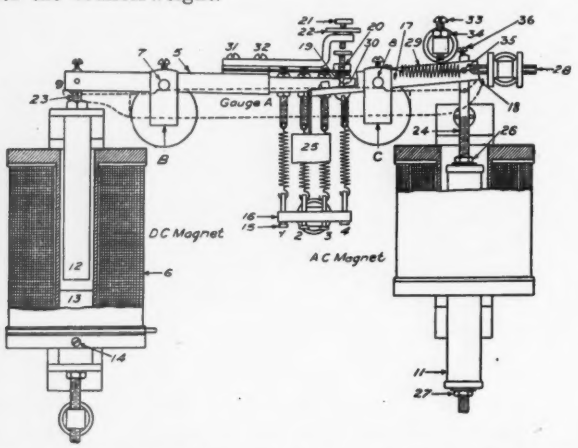


FIG. 14. ARRANGEMENT OF MAIN CONTACT COILS AND LEVER

It also follows that any increase of voltage will cause the plunger to assume a higher position with a corresponding movement downward of the lower main contact; any decrease of voltage will in the same manner cause an upward movement of the lower main contact.

By properly adjusting the a.c. solenoid plunger up or down along its stem (and so causing it to float in a field of the desired flux distribution) it is possible to produce a motion of the lower main contact of a value sufficient to maintain practically a one to one ratio between the error in voltage and the corrective effort.

Under the conditions as outlined above, the regulator would then (if properly adjusted) hold the voltage normal at all times, regardless of load and external conditions. If, however, the distance between power house and center of distribution is great enough to produce an undesirable drop in voltage, a compensating device must be used in connection with the elementary regulator. The function of such device is to produce an increase of bus voltage proportional to the load carried in some main feeder taken as a standard. It must necessarily be adjustable to the resistance of this standard feeder.

The compensating mechanism is simple, consisting merely of a winding on the a.c. control magnet energized from a current transformer in the "standard" feeder and having a dial switch arranged to cut out of circuit all of or any position of the turns. This compensating or compounding winding is connected in such a way that the magnetism generated by it opposes that of the potential winding, previously considered. With any setting of the dial switch, a counter flux in direct proportion to the current in the feeder, is produced. This counter flux weakens the upward pull of the a.c. magnet, and produces a movement upward of the lower main contact, which in turn finally results in an increase of maintained a.c. voltage.

Under conditions of poor or rapidly changing power factor, with consequently varying angle of displacement between voltage and current in the standard feeder, complete compensation can, however, not be obtained by the simple device above. Under such loads the following conditions obtain:

a. The voltage drop does not vary as the ohmic resistance and load alone, but has introduced the third element of power factor.

b. The compensation is also incorrect because the movement of the plunger is no longer dependent on the magnitude of the current alone but also upon the angle it makes with the voltage.

To provide for such cases a scheme such as shown in Fig. 10 is used. The compensating coil around the a.c. control magnet is disconnected, and voltage supplied

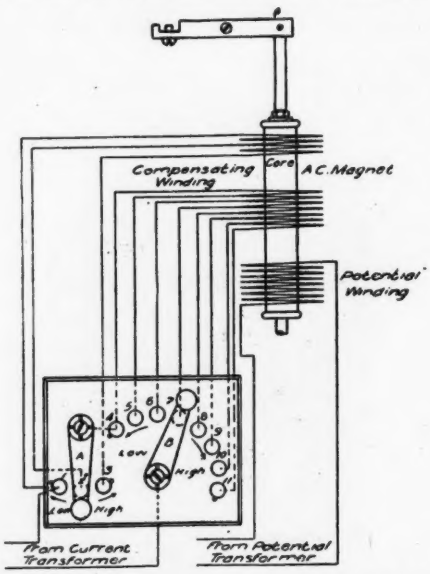


FIG. 15. DETAILS OF COMPENSATING COIL CONNECTIONS

to the potential winding through a line drop compensator. This compensator (by means of the dials R and X) can be adjusted to fit the characteristics of the line—and so supply the a.c. control magnet with a voltage equal to that at some predetermined point of regulation.

In general the compensator may be said to be a device which automatically subtracts from the voltage at the terminals of a potential transformer, an amount equal to, or proportional to the drop between the point on the line where the transformer is located and some other selected point.

Thus in Fig. 11 we have the internal elementary connection of such a device. It will be noted that current from the current transformer passes through a series of reactances and resistances—the number of which is controlled by two dial switches. Thus the drop from

A to B is proportional to the current in the feeder and to the resistance and reactance characteristics of the line. When, by calculation or experiment, the dials have been properly adjusted, the voltage across S is equal to the voltage TU, less drop AB.

Closing of the relay main contacts reduces the magnetism of the relay core to zero. As a result, when the main contacts are opened there is no "discharge flash" or "inductive kick" due to the collapsing lines of magnetism as would be the case if the process were reversed and the main contact when closing energized the relay cores. Thus, by a simple and quite well-known expedient, arcing at the main contacts has been eliminated.

The Tirrill Regulator

In Fig. 12 is shown a Tirrill regulator, and in Fig. 13 a diagram showing it connected for the regulation of a number of exciters in parallel.

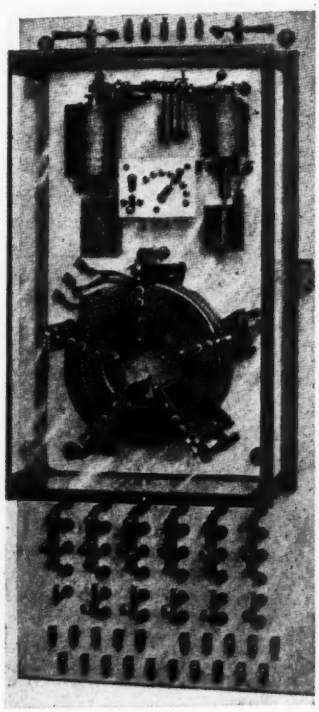


FIG. 16. SHOWING USE OF CIRCULAR COIL FOR CONTROL OF RHEOSTAT SHUNTING CONTACTS

It will be noted that it differs from the elementary regulator only in details provided for convenience of adjustment, connection, and operation. Terminal posts have been provided for the connections which must be made to various separately mounted portions of the apparatus, and to the rheostats and busses.

Some of these connections are made through reversing switches; namely, those from the main control and relay contacts. This arrangement permits a change in the direction of current flows through these parts—and equalizes the wear on the contact points.

In Fig. 14 is shown the arrangement of the main control coils and the levers controlled by them. The d.c. lever has a flexibly mounted adjustable point, the limit of movement of which is controlled by stop screw 21. It will also be noted that there is in the d.c. coil an adjustable stop core 13.

There are four springs, 1, 2, 3 and 4, which oppose the d.c. magnet pull, and which are brought into action at different times. By adjusting these springs and stop core 13, it is possible to make the interaction between the opening and closing forces such as to maintain accurate voltage.

A. C. Control System

Referring to Fig. 14, it will be seen that the a.c. system does not differ materially from its elementary

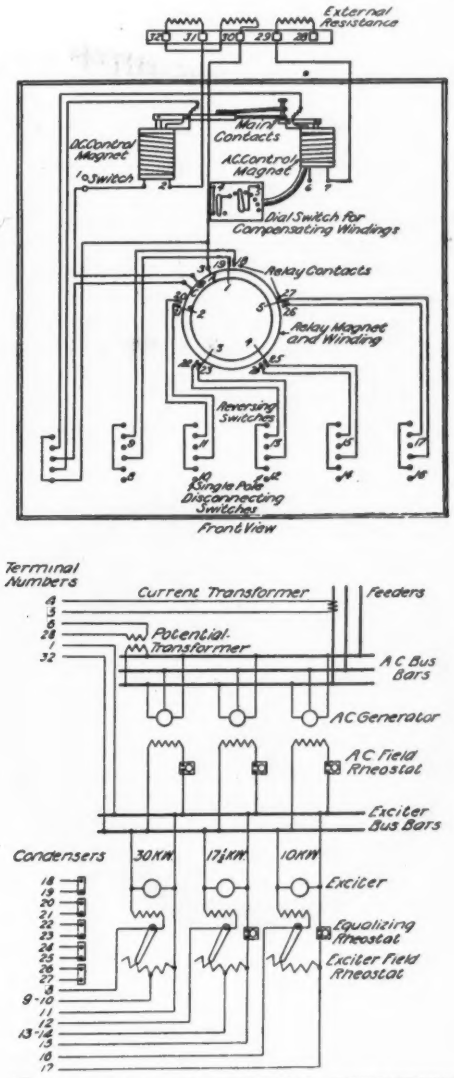


FIG. 17. INTERNAL AND EXTERNAL CONNECTIONS OF REGULATOR SHOWN IN FIG. 16

form. There has been added a limiting screw 33, an adjustable spring 29, and the core 11 has been made adjustable up and down by means of threaded stem and locknuts 27. Counterbalance 25 consists of a pan or cup filled with shot. By adding or removing shot, the preliminary or coarse adjustment is made, while the final or fine adjustment is obtained by means of screw 28, which varies the tension of spring 29. Core 11 is

made adjustable in order that it may have its "pull" curve varied. That is—by moving this core up or down—it is brought into a field of different distribution, so that a change of voltage has a correspondingly different effect on it.

The compensating coil winding, Fig. 15, is arranged in three layers, the first two being controlled by lever A, and thus forming the coarse adjustment; the third layer is subdivided into seven sections and controlled by dial switch B. The secondary current from the current transformers can be made to flow through a fraction of a layer of wires by leaving switch A on 1 and moving B to the right, or through either one or two whole layers and a fraction of the third by setting A on 2 or 3 and B to the right.

The "one relay" regulator is applicable to several exciters in parallel if their capacity is not too great. On large machines it is often necessary to divide the shunt field rheostat into segments or sections, each controlled by a pair of relay contacts on the regulator. In order to simplify matters a relay magnet has been devised, as shown in Fig. 16. Here one circular coil controls simultaneously the action of (in this case) five rheostat shunting contacts.

In Fig. 17 are shown the internal and external connections of this regulator.

Designing an Electric Temperature Indicator

PRINCIPLE OF OPERATION AND METHOD OF MAKING REQUIRED CALCULATIONS. BY V. H. TODD

IN one class of electric temperature indicators, of which the instrument shown in Fig. 1 is a typical example, advantage is taken of the variation in the resistance of copper wire with temperature, to unbalance a Wheatstone bridge arrangement, and thus produce deflection of the pointer over a suitable marked scale, thereby indicating the temperature of the wire direct, instead of merely its resistance. The outfit consists essentially of the coil of copper wire, called the "exploring coil"; a high sensibility direct-current voltmeter, preferably of the moving-coil permanent type, and three

FIG. 1. TYPICAL TEMPERATURE INDICATOR

resistors, mounted conveniently in a "bridge box" such as is shown in Fig. 2. The exploring coil is wound with many turns of fine insulated copper wire, and is imbedded in the transformer coil, generator field, or any other place, of which it is desired to know the temperature. From the exploring coil suitable leads are run to the bridge box and meter, which may be located at any convenient point. The outfit is then energized by a source of constant direct-current potential, preferably a storage battery.

PRINCIPLE OF OPERATION

THE CONNECTIONS are shown diagrammatically in Fig. 3. When the resistance of the exploring coil is equal to the resistance of each of bridge arms, A, B and C, there will be no flow of current in the direct-current indicator. But if the temperature of the exploring coil should increase, its resistance will increase, and there will be a flow of current in the indicator; the flow of current and the consequent deflection of pointer will be proportional to the increase in temperature. In a similar manner, any decrease in temperature will produce a current and deflection in the opposite direction.

Although this type of indicator has been in use for many years, its design has been accomplished largely by the cut and try method, and but little attempt has been made to calculate the currents in the various meshes, especially in those containing the indicator, to determine

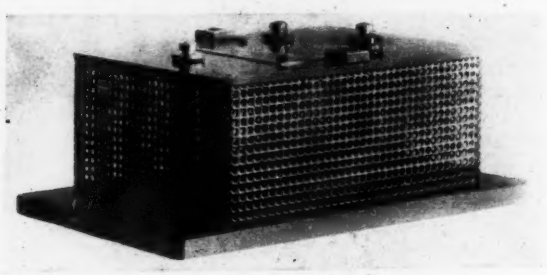


FIG. 2. BRIDGE BOX

the sensibility of the instrument required or if a given instrument will give the proper deflection on a specified variation in temperature.

The object of this discussion is to determine (1) the resistance of the exploring coil at various temperatures; (2) the value of the current in the indicator at the maximum and minimum temperatures; (3) the current in the exploring coil; and (4) the total current taken from the line.

ASSUMED VALUES

IN ORDER to demonstrate the calculation more clearly, let us assume certain values on which to base the calculation. For the exploring coil, it has been found that a coil wound to 30 ohms at 100 deg. C. of No. 36 S. S. C. copper wire will make a good, compact coil. This means that each of bridge arms, A, B and C, must be of 30

ohms resistance, and of wire having a negligible temperature coefficient. A No. 36 wire would, on a strip of mica 6 in. long by 1½ in. wide, carry about 0.03 amp. without injurious heating. Since this is in a split circuit, the sides of which have equal value, the current drawn from the line will be approximately 0.06 amp. If a 110-v. direct-current circuit is to be used, the value of the external resistor must be about 1800 ohms.

The copper resistance of an instrument like that shown in Fig. 1 will be about 20 ohms, and to this must be added at least 30 ohms of non-temperature coefficient wire in order to minimize the self-heating error of the instrument itself. With these assumptions, we are ready to find out if this voltmeter will give a deflection from one side of the scale to the other if the temperature of the exploring coil varies from 0 to 150 deg.

Resistance of Exploring Coil

If the exploring coil measures 30 ohms at 100 deg. C., then the resistance at 0 deg. C. may be determined from the formula:

$Ro = Rh\ (1 - 0.003{,}870{,}lt + 0.000{,}009{,}009t^2)$, in which Ro = resistance at 0 deg. C., Rh = resistance at a high temperature, and t = high temperature in deg. C. Substituting the values of 30 ohms for Rh, and 100 deg. for t, we find the coil will measure 21.0927 ohms at 0 deg. C.

By transposing the formula with Rh for the unknown, substituting 21.0927 ohms for Ro and 150 for t, we find that the resistance of the coil at 150 deg. C. will be 33.9008 ohms. For practical purposes and to avoid excessive figuring, these values may be used as 21.1 ohms at 0 deg. and 33.9 ohms at 150 deg. The outfit now shows the values in Fig. 4. In a similar manner, the resistances at any desired temperature may be calculated.

Calculating Mesh Currents

The current in the indicator circuit may now be calculated from Kirchoff's laws, using the method of determinants, or solving the equations by Maxwell's method of considering fictitious currents to exist in each mesh, and the actual currents to be their algebraic sum. This last method is perhaps the simplest. The equations for each mesh are obtained as follows:

(1) Multiply the total resistance of the mesh by the symbol representing the fictitious current.

(2) Give this a "plus" sign if current is counterclockwise and a "minus" sign if clockwise.

(3) Subtract from this, the sum of the products obtained by multiplying the symbols representing the current in adjacent circuits by the resistance of the mesh side common to both.

(4) Equate this to the voltage produced in the mesh.

Thus, in Fig. 4, if we assume the currents to be x, y and z, and counterclockwise in direction, we obtain the following equations:

$$(1800 + 30 + 30)x - 30y - 30z = 110.$$
$$-30x + (30 + 50 + 21.1)y - 50z = 0.$$
$$-30x - 50y + (30 + 30 + 50)z = 0.$$

For the high value of exploring coil:

$$(1800 + 30 + 30)x - 30y - 30z = 110.$$
$$-30x + (30 + 50 + 33.9)y - 50z = 0.$$
$$-30x - 50y + (30 + 30 + 50)z = 0.$$

Solving the first set of equations for y and z, gives: y equals 0.012,15 and z equals 0.011,48. The algebraic sum 0.000,67 represents the current in the indicator circuit, tending to deflect the pointer from 100 deg. to 0.

Solving the second set gives y equals—0 0109 and z equals 0.011,18. Their algebraic sum gives 0.000,28 amp., the value of current tending to deflect the pointer from 100 deg. to 150 deg.

The sum of these two currents will give the total variation of current necessary to deflect the pointer from the extreme left to the extreme right-hand side of the instrument required and may be expressed in amperes or in ohms per volt, which in this case would be 1050 ohms per volt.

The values of y in the formula will give the maximum and minimum currents to be carried by the exploring coil. Solving for x will give the exact current drawn from the line.

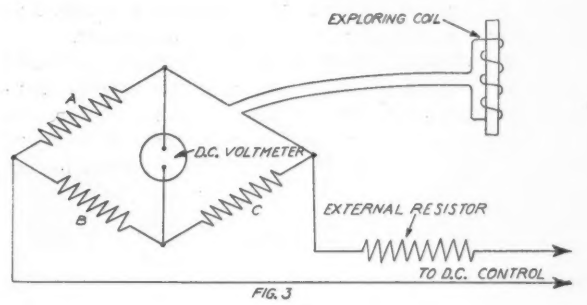


FIG. 3

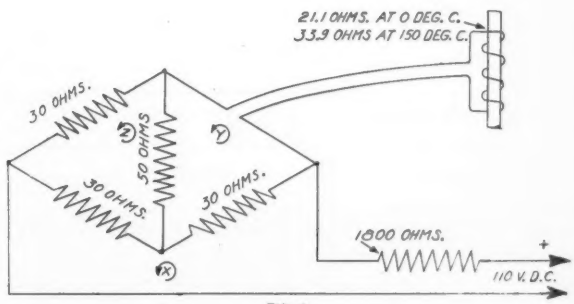


FIG. 4

FIG. 3. DIAGRAM OF CONNECTIONS
FIG. 4. DIAGRAM SHOWING ASSUMED VALUES

Calibrating

After having proved that a certain meter is sensitive enough to indicate the desired extremes of temperature, it is customary to complete the final calibration by connecting the outfit as in service with the exploring coil placed temporarily in an oil, or airbath, the temperature of which may be controlled and accurately measured. The adjustment may be made, using the demagnetizing process to vary the sensibility of the meter, or by adjusting the external or internal meter resistors, until the maximum and minimum points correspond to the temperature of the bath, and then marking in the remaining main points by direct comparison, interpolating the intermediate and sub-divisions.

On Aug. 30, national debt of United States was $26,526,701,648.

Heavy Alternating-Current Conductors

By K. C. Randall

THAT the inner portion of a solid conductor is of little use with alternating currents, especially at higher frequencies, is common knowledge. That a subdivision of the conductors as approximated in ordinary stranded cable offers somewhat better conditions, especially if the individual strands are in poor contact one with another, is also generally understood. Some special construction whereby all the elements of the total conductor are caused to average the same position throughout the total length and also all have the same resistance, would afford a quite perfect theoretical solution and bring the alternating-current conductor to practically the same basis as obtained with direct current. In practice, no such construction is attained, and generally this fact offers no serious disadvantage.

In very heavy alternating current work, particularly as found around electric furnaces, where several thousand amperes at perhaps 60 cycles have to be carried for some distance, the problem of current distribution throughout the conductor is one of the principal factors

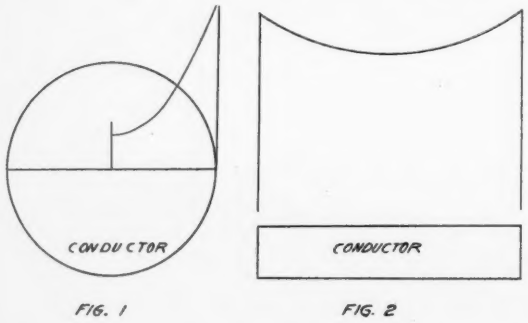


FIG. 1. ALTERNATING CURRENT DISTRIBUTION IN ORDINARY CIRCULAR CONDUCTOR

FIG. 2. ALTERNATING CURRENT DISTRIBUTION IN HEAVY BUS BAR

in determining the total conductor design, and may even vitally concern the construction of the supply transformers and the furnace itself.

Figure 1 shows how the alternating current distributes itself in an ordinary circular conductor, and Fig. 2 is for the usual heavy bus arrangement. From both of these figures it is apparent that the inner portion of conducting material is of comparatively small value and that the outer portion carries by far the greater current density. Figure 3 illustrates the current distribution in adjacent conductors due to the influence of one upon the other, and here again—as in the single conductor—the current density throughout the conductors is not uniform and, therefore, the material is not used to a maximum advantage. A method is proposed for largely overcoming this difficulty and causing a more uniform current distribution to obtain throughout the parallel alternating-current conductors.

To take care of the defects with the individual conductor, a tubular construction is used, i. e., the center of the conductor, which is of relatively little value, is eliminated. The surface of this tubular conductor is subdivided, so that its several elements may be caused to average the same relative position with regard to the adjacent parallel conductor that influences the current distribution in it.

This will be accomplished by using a considerable number of relatively small cables insulated from each other and distributed uniformly over the periphery of an imaginary tube throughout the length of the run, at each end of which they are fastened to circular terminals. The conductor runs should be given a twist of 360 deg., or some multiple of 360 deg., so that each individual cable will average the same position and have the same

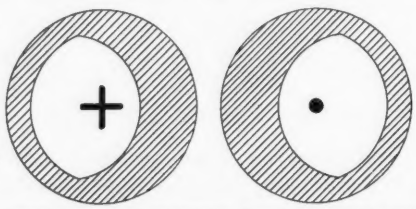


FIG. 3. CURRENT DISTRIBUTION IN ADJACENT CONDUCTOR DUE TO INFLUENCE OF ONE UPON THE OTHER

resistance as each other cable element. In this way there will be no choice in the paths for the current, or, in other words, the impedance of each path will be the same and therefore a uniform current distribution will result.—The Electric Journal.

Tungsten Contacts

By M. H. von Fleischbein

THE scarcity and costliness of platinum in Germany has led to the extensive use of tungsten for make-and-break contacts. The advantages of platinum are its great resistance to oxidation, hardness and high fusion point. Tungsten is found to be unaffected by steam or acids at ordinary temperatures, and stands up well under breaks repeated up to 15 or 20 times per second; that is, with currents from ½ up to 10 amp. If the intensity of the current varies in this proportion, however, sparking cannot be prevented by putting in a capacity or a resistance.

In using a pencil of tungsten of 3 mm. diameter as fixed contact, associated with a movable platinum contact carried on a spring, there was no sign of wear at the end of 6 mo., although the spring was blued as the result of heating. After modifying the mounting so as to avoid this, the intensity of the current was tripled without injury to the contacts. The tungsten contacts are soldered electrically to their supports in an inert atmosphere; these supports being of bronze steel or nickel silver. The contacts must be very short on account of the high resistance of this metal.—Elektrotechnische Zeitschrift.

Government experts have urged upon the senate committee investigating the coal shortage situation the urgent need for a federal clearing house of information about the coal industry, so that the public may know about the cost of production, selling price and the output. The coal output is reported increasing, but there is no present prospect of the coal shortage being remedied.—Chicago Commerce.

Breaking Water Pipe Saves Engine

Elevator Fire Consumes All But Power Plant Machinery

IN THE resumption of operations on the part of the Kentucky Public Elevator Co., Louisville, a few weeks ago, after being out of commission for over 2 yr. as a result of a bad fire, attention was called to the fact that although the power plant was partly wrecked, the old machinery came through the fire in grand style, and is driving the machinery in the new concrete mill, which replaces the old frame mill building, at a cost approximately a half million dollars. Incidentally, the workhouse or mill section has a capacity of 250,000 bu. or cost $2 a bu. capacity to erect, but it carries a 19c insurance rate as against a rate of $2.25 before the fire. The present rate on the same class of risk would be about $5 per hundred.

This mill is operated throughout with rope drive. Rope drive from the engines operates a jack shaft through a tunnel from the power plant to the elevator,

FIG. 1. AFTER THE FIRE, SHOWING RESULTING DAMAGE TO POWER HOUSE

and rope drive from a big pulley in the elevator transmits power to all sections of the plant, with the exception of a few motors for handling dust fans, etc.

The company refers to the power plant as an old plant; but it can hardly be classed as an old plant today, as the machinery is running sweetly in spite of having been through a fire.

How the Engines Were Saved

During the big fire in February, 1917, a brick wall at the north end of the power plant crashed in on the machinery, and tons of burning grain, timbers, etc., followed the wall. A 2½-in. water line, however, broke over the engine when the wall fell, and the constant stream of water kept the mass over the engines cool to a point where the metal was not injured. After the wreckage was removed from the engine room it was found that the engine governors and a few small parts were broken and wrecked, but the body of the engines, condensers, and other equipment was not even hurt. The power plant, that is the boiler room, was not even heated up, and supplied steam during the reconstruction period.

The power plant at the elevator is divided into two sections, a brick dividing wall being between the engine

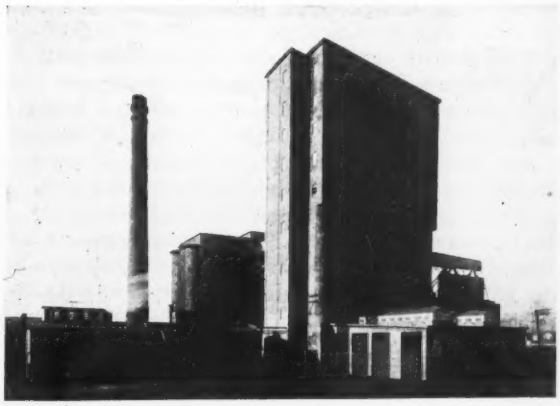


FIG. 2. NEW ELEVATOR, WITH POWER HOUSE AT THE LEFT

room and boiler room. The power house is 90 by 45 ft., and 25 ft. high, with a glassed-in cupola to admit light. The engine room is equipped with two Corliss engines, made more than 25 yr. ago, one being a right hand, the other left hand engine, adjusted so that one engine leads the other, with small chance of getting on a dead center. The flywheel is grooved and carries 14 2-in. strands of rope, which drive a similar wheel con-

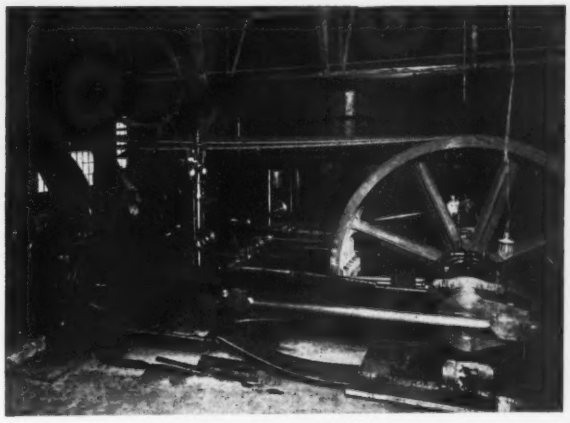


FIG. 3. 750-HP. TWIN CORLISS ENGINES WHICH PASSED THROUGH THE FIRE

nected with the jackshaft. These engines have a rated capacity of 750 hp., and are operated together, although during one period of six weeks the company managed to operate with one engine while the other was out for repairs.

In the boiler room, are three water-tube boilers, two of which have been in service for 25 yr. These two

boilers are of 225 hp. capacity each, making 450 hp. for the battery; while the third boiler is of 350 hp. capacity, and has been in operation 8 yr. The boilers are bricked in, insulated with asbestos, and steel jacketed. The twin boilers have large doors opening at either end, making them accessible for cleaning, repairs, etc.

This plant was established in 1881, and operated one of the largest elevators in the South.

Exhaustive Investigation Wasted

By Frank Richards

NOT LONG ago there appeared in Zeitschrift des Vereines Deutscher Ingenieure the account of an exhaustive investigation made by the writer of the article into the cause of the fracture of two compressed gas cylinders—one for hydrogen and the other for oxygen—which burst while in course of filling.

The hydrogen cylinder was being filled with the gas at a pressure of 140 atmos. The explosion was extremely violent; the floor on which the cylinder was standing was found to have a hole in it 75 cm. deep; the flask or cylinder flew upward like a projectile, passed through the roof of the filling room, and fell in a garden some 85 m. distant.

An examination of the plant (compressor and fittings) revealed it to be in order.

The gas was produced electrolytically and collected in a gasholder, after which it passed into a two-stage compressor and was compressed to a filling pressure of 150 atoms.

A full chemical, mechanical and micrographic examination was made of the fractured cylinder, from which the writer concluded that it satisfied the requirements of the authorities. Probably a "fold" or crease formed in the steel while being mechanically treated, and this creasing gave rise to a crack or cracks, which were most likely the cause of the explosion.

He suggested that in addition to the prescribed precautions relating to the inspection of these vessels, each seamless vessel should be "flash-tested" (this test is not defined) before the head is put on, in order to find faulty places. This method has been adopted by the military authorities prior to the acceptance of all shells. This test would enable any creases to be discovered in the steel.

In the case of the oxygen cylinder a greater number of splinters were available.

The cylinder is said to have burst during the process of filling at a pressure of 80 to 100 atmos. The oxygen used was obtained from liquid air.

The cylinder was of similar construction to the hydrogen cylinder, being of the seamless-steel type. The same official regulations applied in this case also.

The article describes in detail the mechanical, chemical, etc., tests carried out on the fragments collected.

Numerous causes contributed to the bursting of the cylinder as shown by the experimental results.

The steel was weakened at one particular part where the test initials were stamped, as the stamp penetrated to half the wall thickness of the cylinder.

The steel was too brittle for the purpose in question. It was very sensitive to dynamic stresses.

The author suggested that the regulation regarding the stamping of these cylinders should be modified. The stamping should be reduced to a minimum, and be done when the steel is in a red-hot state.

A mere pressure test is, when employed alone, very defective. It is much more important to test the inside and outside surfaces and the thickness of wall of each cylinder prior to putting on the top.

Basing my discussion on the above abstract of the report, it should have been immediately apparent that the explosions which occurred were not ordinary pressure explosions. They were not due to the giving way of the cylinder material under the regular and accustomed pressure for which they were designed and to which they had been previously subjected, and especially when apparently the limits of such pressure had not been reached; and the investigation as reported, based upon such an assumption, could throw no light upon the matter and was, of course, worthless.

What really happened must have been the formation of an explosive mixture of gases, or of gas and air, and then the ignition or firing off of the mixture and the coincident sudden generation of a pressure probably many times greater than the metal could have withstood. The occurrence under a variety of different conditions is not so infrequent as might be supposed.

The investigation should probably have been first conducted by chemists who could have determined the precise gases present, their condition and their proportions, and then the question would have been as to the production of such a temperature as would have caused spontaneous ignition of the explosive charge or mixture without the presence of spark or flame.

The means of producing the high temperatures we are here looking for are distinctly suggested in even the few words which sketch the incident of the explosion. There may be and often is compression of air or gas, with the inevitably accompanying rise of temperature, without the intervention of any mechanical compressor. In the present case, the contents of the cylinders had been discharged in service and they were to be refilled. While they were, as we could think and speak of them, empty, they were really full of gas or air at a pressure not below atmospheric and perhaps somewhat above. When, by the operation of recharging the cylinders to the high pressure spoken of, the surviving contents of the cylinder at low pressure and normal temperature were compressed by the incoming gas, and the temperature was raised correspondingly, so that if the constituents and the proportions of an explosive mixture were present, the explosion was sure to occur. Many "mysterious" explosions which have occurred in the recharging of high pressure receivers for air and for the various gases are thus easily explicable, but how they may be surely prevented it is not so easy to suggest. Certainly the recharging should not be done rapidly.

An engineer, strolling past the switchboard, noticed the circuit breaker open on a high-tension feeder and the operator sound asleep in his chair. To be a good fellow and keep the operator out of trouble, he stole up and closed the switch, then went on his way. When he energized the feeder, he killed a lineman who was working on it.

Experiences at the Glendale Plant

A Letter from John Blake to Albert Wallace and the Reply. By G. H. Kimball

DEAR WALLACE: We have had to run the oil engine most of the day time for the past two weeks and it is ticklish business for Graham, as he does not understand them very well and has depended upon us to keep them going right. They are doing as well as could be expected but the valves must be looked after soon. There will be some fun when they have to start the 400-hp. steam engine with the new valve setting. When the days get shorter I hope we have plenty of rain, so that the engines have some help, for if it is dry there will be something doing.

I am glad to hear that you got a license so that you can run the steam plant as well as the oil engines although you will have enough to do with them I think. You are certainly up against a funny sort of man in that fellow Gooch, and it is hard to see what his game is, but I think that you will win out in the end, and of course I hope so. Tell me more about the place when you write. What have you had to do to the engines and how are the compressors arranged? I am very much interested in those things just now.

I was somewhat surprised the other day to have Graham come over to me and say, "Well! Blake, I am going to leave you next week." Of course I was somewhat taken aback for a moment, as he has been here such a short time; and think of the years that you were here. I said, "Is that so?" and remarked that he had not been here long. Then he spoke of his family not being here and he thought that the job was too much with the help that was furnished and that he had got a job at the St. Andrews School plant which is in his home town. He did not say so then, but I found out later that he had been engaged as an oiler, which is somewhat different from chief engineer of this plant. It is plain that he was no man for this place and I should be glad to see him go for the good of the plant if I had not seen his successor when he came here the other day. He is a man almost sixty years old, and Graham was so anxious to get away that he recommended him to Wilbur, and I suppose that the manager thought that he was worth trying, so he is coming soon. We can now look for more trouble.

We were running along all right the other day with all of the compressor valves working well, when the first stage relief valve opened. Graham and the new man were looking on when I shut it down. He came down the steps rather slowly, I though, as if he was afraid of getting into a fix and he said, "What do you make of it?" I said that I could not tell. We looked at the valves but they seemed all right, so we put them back in place and started the machine up and it went all right, much to Graham's relief, I think, for he does not want anything to happen while he is so near the end of the job. What the other man thought is hard to say, for he did not express his feelings. Perhaps you can explain what happened sometime so I can fix it if it sticks again.

Yours truly,

John Blake.

My Dear John:

You have asked for some news of this plant and most of this letter will be devoted to replying to your request. I told you of the plans to build a new power station before I left Glendale; well the work has commenced both on the plant and on the new factory near it. The unit that we are running now is new and is in a wooden house that is just large enough to hold it comfortably. It is very comfortable for the roof is high enough to swing the pistons and rods clear of the cylinders, and there is a traveller that runs along an I beam fastened to the roof timbers. So you see it might be worse. The compressor is about double the capacity of the ones that you have and it is driven by a 55-hp., 550-v. a.c. motor by means of a chain. It has about a dozen oil cups on it, which is not as good as the splash oiling kind that you have. You remember how we used to look after the oil engine, and considerable other machinery besides, up there; I was surprised to see three men here to run this unit and one of these was Mr. Gooch. He does not do anything, so the two oilers keep things in good shape. One of them spends lots of time filling the oil cups on the compressor. The fuel feeding system is different from yours, for none of the pumping is done by power. At present they are hauling the oil in a tank wagon and it is then pumped by hand into a barrel through a strainer and from the barrel to a 30-gal. tank up on the wall. This has a scale in front of the gage glass, so they keep account of the oil every time that the tank is filled. I began to see where the help was needed.

There seems to be plenty of men around all of the engine rooms here, but I think that Curley will cut some of them off soon, from what I heard him say. We have had our troubles with compressors too; first, by valves sticking, and then gaskets blowing out on the third stage head. Gooch took the sticking valves out and cleaned them very carefully, which fixed them for some time. The trouble is caused by too much oil being fed into the high pressure cylinder, and it does not take much of it to make the valves stick.

We have had two shut-downs from the above causes and today just as we were getting ready to shut down at noon the compressor stopped with a jerk, and we found that the piston rod was broken, so we had to close down for the day. Curley gave orders to go up and start the other engine that is to be moved down here alongside of this one. Part of the unit has been dismantled, so we could get but half load from it. The compressor is an old type and just big enough for three cylinders and it had been allowed to freeze up some time and the water jacket leaks into the cylinder on the first stage so that you have to be blowing water out most of the time.

I had just got the air up to pressure when Curley told one of the oilers to look after it and for me to go and take the rod out of the compressor at the new plant. I went down and had very fair success with it and by six o'clock I was ready to turn her over. I had packed the third stage cylinder with heavy Manila paper like

Gooch used and it blew out as soon as the pressure came up to 1100 lb. I went to supper then, intending to return and repack it. I will tell you what luck I had in another letter.

So Graham is going to leave. Well, he is not much of an engineer after all, and I hope that the new man will do better. You surely are having your hands full. There is going to be plenty of work here for some time I think and it is hard to make Curley see the needs of an oil engine plant.

Your friend,

ALBERT WALLACE.

New Ways to Put Safety Across

APPLICATION OF HUMAN ENGINEERING TO SAFETY WORK.

SAFETY ENGINEERING involves to a large extent the practical application of human engineering. This point was brought out by H. P. Heyne in a paper read before the Eighth Annual Safety Congress of the National Safety Council. It is necessary in order to promote that spirit of co-operation, necessary to the elimination of accidents, so to handle the men that they will not only think, but work, with the management instead of merely for the company.

In large plants it is usual to appoint safety committees in each department, whose business it is to see that all unsafe practices and conditions are, as far as possible, eliminated. In appointing such committees it is beneficial, where a considerable number of foreigners are employed, to have this class represented, as it helps to create in them and their countrymen a feeling of Americanism, which might not otherwise exist.

Safety plans should be changed from time to time, as this helps to create enthusiasm by giving something new to think and talk about. A further aid in fostering the proper spirit is secured by taking the committees into confidence and asking their opinion on any new propositions.

ACCIDENT INVESTIGATIONS

INVESTIGATIONS, properly conducted, are frequently the cause of corrective methods being installed. Accidents involving loss of time should be investigated. All witnesses should be examined, the injured employe's statement taken, and the conditions at the place where the accident occurred, should be gone into. This information should all be tabulated and made the basis of periodical reports, showing, in the larger plants, the standing of the various departments, and helping to create a spirit of competition between the various departments to secure the best record.

The possibilities for safety propaganda in our schools should not be overlooked, as the subject can be so presented as to make it attractive to the students.

The man chosen for the position of safety engineer should be an example of good-fellowship; one who has a word of encouragement for the unfortunate, as well as the ability to enter sincerely into the enjoyment of another's good fortune. Courtesy is another valuable asset to the safety engineer, materially helping to dispel the illusion that he is, by virtue of his office, always trying to "get something" on somebody.

Turbine Reduction Gears

BY MARK MEREDITH

EXPERIENCE with turbine gears under service conditions, has demonstrated the fact that no serious trouble need be anticipated, provided a reasonable amount of care be taken in running the machinery. In a few isolated cases, failures have occurred in breaking of pinion teeth, or in their excessive wear; but these troubles have been, usually, traced to faulty design or to the materials used in construction, or due to misalinement of the pinion with respect to its gear wheel. In some cases, examination of the pinion teeth has revealed a certain amount of pitting of the teeth surfaces, and several explanations have been given for the cause of this trouble. A commonly accepted theory is that, in teeth cut by the hobbing process, there are left on the tooth surface a number of high points due to the intermittent cutting action of the hob; when the gear is transmitting power, these points are subjected to intense pressure, which causes lamination of the material, and in due time these laminations flake off, leaving small pit holes in place of the former high points. It has been suggested that these high parts might be removed by filing; but the process would be somewhat laborious, and there is also the danger of destroying the general form of the tooth by hand work.

In operating the gear, a copious supply of oil should be given, which will relieve, somewhat, the high local pressures, and in time these high points will be gradually worn down to the level of the tooth surface. In designing these gears, especially of the rigid type, a nominal pressure per unit length of face should be given, and to prevent noise and vibration when running, high tooth speeds should be avoided.

Science Organized

AMERICA prides itself on its genius for organization. To say that a man is a great American is almost to say that he is a great organizer. We have gone far and gained much in organizing our business, our industry, our agriculture, our labor; but, strangely, we have not organized our science.

America made its first step along this line in establishing the National Research Council, the avowed purpose of which is to mobilize the whole strength of American science for the promotion of the national wellbeing and the advance of science itself.

The Great War gave stimulus to scientific research and application and to scientific organization. All efforts to promote the recognized fundamental scientific basis of national strength and wellbeing are outgrowths of the war's revelations.—The Nation's Business.

Method of Tempering High-Speed Steel

FRENCH PATENT No. 487,135, June 5, 1918, has been granted to M. Bagliardi for a new method of tempering high speed steel. The process consists of maintaining the steel at the required temperature for a few minutes and then plunging into a mixture containing nine parts of animal fat and one part of fine wood charcoal, in which it is allowed to cool.

Testing for Armature Troubles

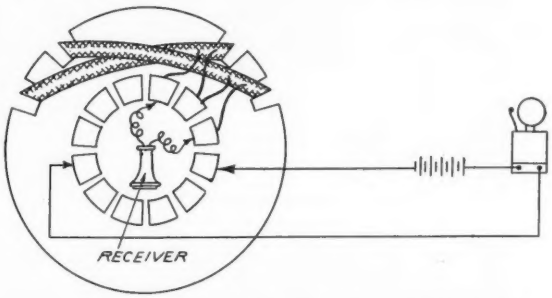
FOLLOWING is a reliable method for locating a reversed armature coil. The method is simple and can be carried out with either a millivoltmeter or by means of a telephone receiver, a dry cell battery and a bell.

Such armature troubles as short-circuited coils, opens, bad contacts, grounds, crossed coils, can be located accurately with an ordinary telephone receiver without opening any coil connection to the commutator.

To locate a reversed coil in an armature, connect the battery and bell in series with the armature as shown in the sketch.

Connect the battery and bell leads the same distance apart on the commutator that the poles are apart on the machine.

The principle of the test is very simple. If an alternating current is sent through a coil a counter voltage is produced in that coil, and if a receiver is bridged



SCHEME OF CONNECTIONS EMPLOYED FOR TESTING ARMATURE WINDINGS

across the leads of the coil, this counter voltage set up will cause the receiver to vibrate, and of course the greater the counter voltage the greater will be the receiver vibration. If the coils are bridged separately by the receiver, the intensity of the vibrations will be the same for each coil, whether it is connected reversed or not; but the induced voltage of the coil reversed will be in the opposite direction from the induced voltage of the other correctly connected coils. If the receiver, however, is made to bridge two coils at once, one of which is reversed, the two voltages of the coils being the same and in opposite directions, they will neutralize each other, hence the receiver will not vibrate, indicating one reversed coil.

I have found that the receiver method of locating troubles in an armature is thoroughly reliable, and has saved many hours of labor in breaking and making coil connections to the commutator. A 110-v. alternating current source of energy, when it is available, can be used to better advantage than battery and bell. An ordinary electric iron in series with the armature will give about the required amount of exciting current.

W. A. DARTER.

Changing Characteristics of Turbine Governors Not Free from Danger

THE GOVERNING MECHANISM of any steam turbine is a vital factor in determining the safety of the unit and its success in accomplishing its purpose. Failure of a governor to function properly has resulted in damaged and wrecked turbines, injury to other apparatus and death to attendants. Adjustments of turbine governors may therefore be made to modify their action, decrease or increase the regulation, etc., but nothing should be done to change the characteristics of the governing mechanism. In this every manufacturer of steam turbines will agree.

On page 815 of the Sept. 15 issue of Power Plant Engineering appears an article entitled "Converting a Steam Plant to Stand-By Service." In this article, mention is made of a practice by which a large utility was enabled to obtain closer parallel operation between certain steam turbines and water turbines installed a considerable distance apart. This was accomplished by changing the characteristic of certain of the steam turbine governors; such practice is not safe, and is not one that should be followed, generally speaking. It is one which the turbine manufacturers will not favor on general principles.

The practice performed, constitutes the introduction of a restraining device. In other words, by employing friction in the governing mechanism, the normal functioning of the governor is interfered with and changed. The characteristic cycle of the governor is changed, and of course, the element of danger is immediately introduced.

The restraining influence described, is equivalent to inertia as far as concerns the functioning of the governor mechanism, hence the control of steam to the turbine runner. This means that additional work is required of the governor mechanism, of the springs, the gimbal bearings and knife edges of the type of governing mechanism used. This means, in turn, that wear and tear are hastened, and while more frequent renewals and adjustments may be necessary, it is absolutely certain that continual vigilance is necessary against failure of the governor at some important instant, due to sticking inadvertently when prompt action is needed.

More than one turbine has been badly damaged because of governor failure. The governor is the all-important factor in the control of steam and it is the governor that determines the proper working of any unit.

To change radically the characteristics of that governor is unsafe, and such a practice as described should be followed, if it must be employed, in a plant where there is ample personnel and the highest standard of supervision. The practice should not be followed in a small plant where one man has several jobs to attend and must cover considerable ground when trouble occurs.

The device as used at San Diego is stated to employ a clamp faced with leather. While the writer has already advanced reasons for not advocating the practice above discussed, he would suggest that where such a thing is done it would be preferable to employ felt instead of leather for the facing of the clamp. Felt gives a much more uniform friction, temperature changes affect felt less than they do leather, the life of the former is longer and it is affected less by oil than is leather; the coefficient of friction of felt is higher than that of leather,

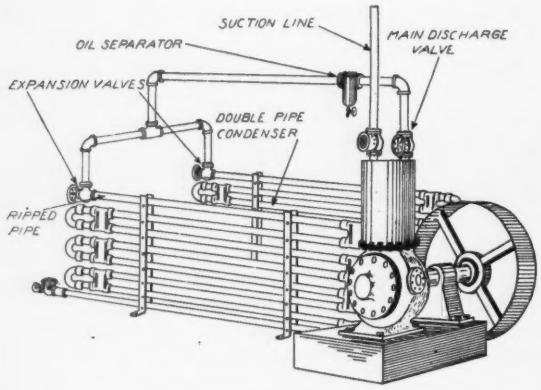


FIG. 1. ARRANGEMENT OF ICE PLANT

also. These advantages are important where inadvertent sticking of the frictional device might cause damage to the turbine. B. W. SMITH.

Ball or Roller Bearings

TO THE operators of roller or ball bearings: I would like to hear some comments coming directly from the plant as to which they find is giving the best satisfaction, ranging in horsepower from 100 to 1000. I am not interested in the cost or the trouble it takes to install them, but in results obtained and troubles encountered with either, stating your horsepower before you install the bearings, and what your indicated load was after you had them in operation; also, the length of time they have been in service. H. W. ROSE.

Ice Plant Explosion

WE HAVE a 15-ton compressor to cool our chocolate room, using the indirect system of a bunker and big fan. The system is rather out of date, as to fittings for cleaning or safety.

About 5 yr. ago it was overhauled by the manufacturer's agent and it has not been cleaned out since. This summer it would have "spells" and the compressor caused all kinds of trouble, so it was decided to have it overhauled again.

A man was again sent from the maker's to do the job, and he started in and fixed valves, crank pin, boxes, etc.; then started after the double-pipe condenser. We took down several sections, to replace sockets and one cracked flange, and then started up the compressor to give it a 300-lb. air test to try the joints.

Now, this condenser showed signs of oil a plenty, and although the compressor is run by motor at constant speed the factory man never stopped until the "smash" came at 240-lb. pressure.

The compressor is located in the northeast corner of the room and the whole force of the explosion went in

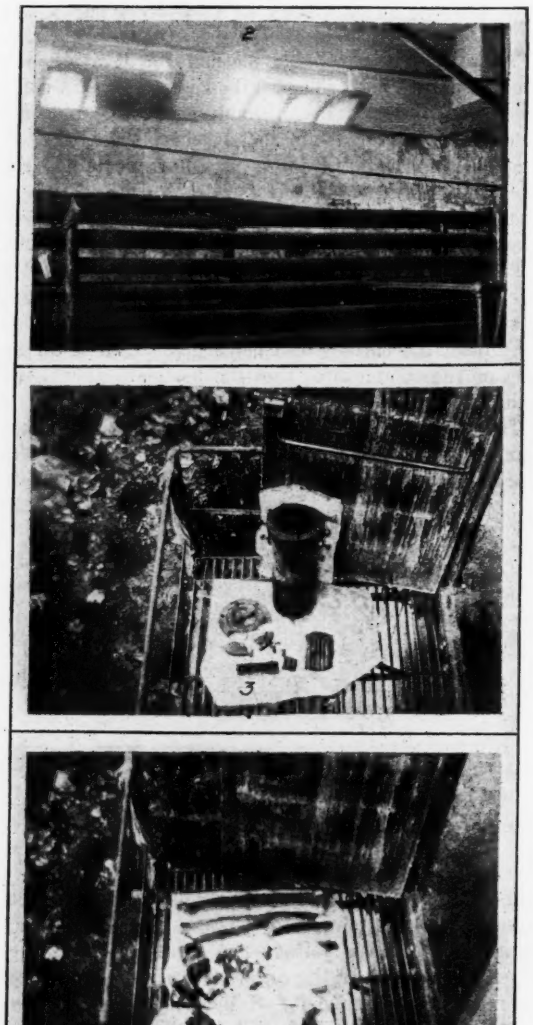


FIG. 2. THE RIPPED CONDENSER TUBES AFTER EXPLOSION
FIG. 3. THE WRECKAGE OF THE OIL SEPARATOR
FIG. 4. SOME OF THE SPLIT PIPE AND BROKEN FITTINGS

that direction, so that only one girl was hit by the pieces. The oil separator lid blew off and broke into four pieces, broke off all six ¾-in. bolts and the inside baffles.

One piece of double thick 2-in. pipe was ripped into four pieces lengthwise and part of it went across the alley. I picked up 29 pieces of broken tees, ells, flanges and two broken valves (all 2-in.).

The top pipe of one condenser unit was ripped wide

open and bent back for about 4 ft. and the flanges or the end were gone. The factory man said he never heard of a machine blowing up like that, and I had to take my May 15 and June 15 issues of Power Plant Engineering down and show them to him before he would believe it was oil that did it.

At the N. A. S. E. the other night, some of the engineers were trying to figure out just about how much pressure was on that pipe when it blew up, because double thick pipe is some pipe.

Figure 1 will show just the way the parts went together so you can see the peculiarities of the wreck.

If the pieces had gone the other way, away from the wall and into the room, it might have been serious, as eight girls were working within 10 ft. of the outfit when it blew up, and the factory man was up on the steps with one hand on the main valves when it let go and the main delivery or discharge valve fell out from under his hand . CHARLES A. STOREY.

A Simple Work Schedule Sheet

THE PROPER working out of the operating plans, repair schedules, etc., without mix-up or delay is in the average plant, quite a task. Many engineers keep a diary, or "date" book, for keeping track of work done, or to be done. In one plant the writer recently visited, the engineer had an entirely novel scheme for keeping

Clean #6 boiler Sunday 12/6/19	Ordered new parts for tube cleaner 10/5/19	Arranged with Clark & Jones to work on cleaning 10/10/19			
Visited Edison Plant to look at Steam Meters	Salesman of Smith & Co. will take party on Saturday 11/4/19				
Fix up spare feed pump packing					

SHOWING USE OF SCHEDULE SHEET

track of various items of work in progress, or to be done. He had tacked upon his office wall a large sheet of drawing paper which he had ruled into 1½-in. squares. As any item of repair, etc., came up for attention, the chief noted it at the left-hand side of the sheet opposite a horizontal row of the squares, the idea being to jot down a note in the next square opposite as some part of the work was done, or if it was delayed, so that at a glance he could tell the status of all matters which needed attention. The general scheme commends itself for adoption in other plants mainly because it teaches the habit of making a note of things to be done or attended to and further, because it shows on one large sheet a survey of the work on hand as contemplated so that plans may be made accordingly. M. A. SALLER.

Protection of Blowoff Pipes

THERE ARE one or two statements in L. A. Cole's letter on page 933, Oct. 15 issue, that should not be allowed to pass without comment. From the wording of his letter, the impression received by the reader is that Mr. Cole does not consider it an improvement to have a circulating pipe arrangement connected to a boiler blowoff pipe; that it is, in fact, not the best method in general use. Perhaps not; however, if he can show where such a statement, or such advice, is given in any modern text book, or in any editorial in any reliable power plant journal, he would be doing good work by giving engineers the names of such books or journals.

It is quite possible that a circulation pipe would get closed with sediment if its blowing out is neglected or the feed water is very dirty, containing a great amount of scale forming material. It is also a certainty that the blowoff pipe would close up under the same conditions. It is a well-known fact that a properly connected circulating pipe of ample size will help to keep a blowoff pipe clear and prevent its being burned, or ruptured by rapid expansion or contraction. The latter can happen to even a clean blowoff pipe which has no circulation pipe attached, by hot gases overheating and momentarily increasing the pressure in the blowoff pipe, thus forcing the contained water into, or partly into, the boiler. As the water rushes back into the overheated pipe, the rapid contraction is apt to cause a rupture. Perhaps this might not occur if the pipe was properly protected, but any loose brick arrangement could get knocked down, or so hot that the protcetion would not be as great as supposed.

Comparing a steam boiler blowoff connection with a water column connection is altogether wrong. Even at that, there are many more scaled-up bottom connection pipes on columns than there are scaled-up blowoff pipes. Many boiler inspectors, I believe, will bear me out in this statement. In a blowoff, connected to the bottom back end of a boiler, the circulating water in the boiler causes much of the sediment and scale forming material to settle around and into the blowoff outlet, with water constantly entering the blowoff through the circulating pipe. Much of this foreign material is washed back into the boiler and lodges on the shell close to the edges of the outlet and when the blowoff cock is opened this material is the first that is blown out.

Of course, all engineers have had their own special experiences; the results gained by one man seem to be directly opposite those secured by another. For instance, in 30 yr. experience I have never seen, in a properly attended blowoff arrangement with a circulating pipe, a burned or burst blowoff pipe; but I have seen many such burned pipes where there was no circulation pipe. Apparently Mr. Cole's experience is exactly the opposite, and it may be well to repeat that I have never seen in print, any statement by any recognized engineering authority against the use of circulating pipes, and in favor of a covered blowoff pipe. To be on the safe side, use both. JOHN THORN.

Standard Practice for Tightening Up Bolts

I HAVE noted with interest M. A. Saller's letter in Power Plant Engineering of Oct. 15, page 932, and beg to advise that theoretically his system, possibly, is a good one, but not for general practice. A bolt may be overlooked with this method, and cause some serious trouble. In work of this nature, the simpler the method, the less chance there is for an imperfect job. My rule is to bring the two flanges together, match the bolt holes correctly, place the packing, have the nuts so that they will run

over the entire length of the threads on the bolts by an easy turn of the hand. Place a bolt in each hole, and screw the nuts on as tight as possible by hand. Starting at some particular point, tighten up each nut half a turn all the way around. Repeat this as many times as necessary to secure the required tightness, always ending with the last nut before the starting point.

By this method all bolts are tightened equally, as there is no chance for any of the bolts to be skipped, and the joint will never leak, if the proper packing is used, and the faces of the flanges are clean and true.

H. W. Rose.

Valve Reseating Tools for Pumps

In the accompanying sketches are shown a pump-valve reseating tool and holders and also three common forms of pump valve seats for which this tool has been designed.

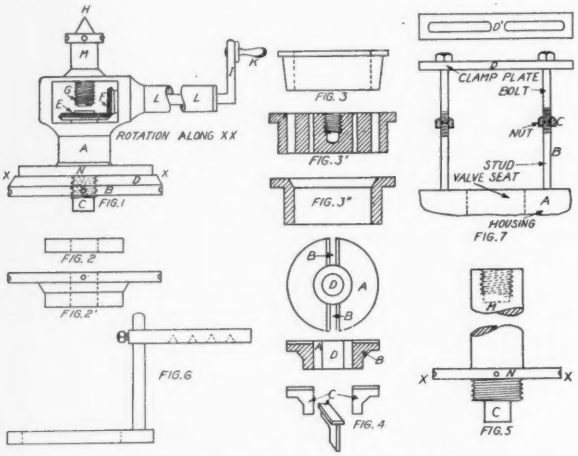


FIG. 1. RESEATING TOOL COMPLETE
FIG. 2 AND 2'. GRINDING AND GUIDE HEADS
FIG. 3. SEAT FOR USE WITH GUIDE SHOWN IN FIG. 2
FIG. 3." SEAT FOR USE WITH GUIDE SHOWN IN FIG. 2'
FIG. 3'. SEAT FOR USE WITH GUIDE SHOWN IN TOOL
FIG. 4. BEVEL AND FACE CUTTER HEAD AND CUTTERS
FIG. 5. EXTENSION HEAD HOLDER
FIGS. 6 AND 7. METHOD OF HOLDING CUTTER TOOLS

Figure 1 represents the reseating tool complete. Housing A is made of cast iron or brass. This is machined on the large face plate N and bored to receive spindle C to which is attached bevel gear E and retainer ring plate D. Hub M is drilled and tapped for the ⅝ by 2½-in. screw GH. Handle LL is 1 by 6 in. long and drilled to receive crank spindle I carrying pinion F meshing with driving bevel gear E and spindle C, motion being transmitted by means of crank and handle IK.

Figures 2 and 2′ represent two grinding and guide heads, the former being a guide plate or center head for the seat shown in Fig. 3, while the other is a guiding head for the seat, Fig. 3″. Head B shown on the tool is for grinding the seat Fig. 3′.

In Fig. 4 is shown a bevel and face cutter head and cutters. The body A is machined over all and bored and tapped to fit spindle C, Figs. 1 and 5; then slotted as shown at B for cutters CC.

Figure 5 also illustrates an extension head holder screwed to tool spindle C, Fig. 1, when so required.

Figures 6 and 7 represent two ways of holding the cutter tool on a Deming pump of the triplex type where the valves are enclosed by a permanent housing. No clamps are required as the tool can be clamped against the valve seat and housing by the screw HG.

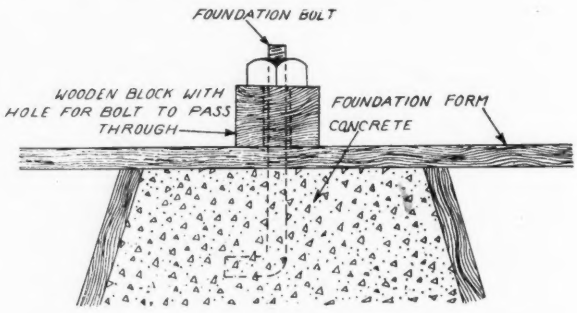
When valve seats of the type shown in Figs. 3 and 3′ are badly worn quick refacing may be accomplished by placing a sheet of emery cloth against the face of the cutter head and clamping between the cutter and ring plate D. A few turns of handle K will do the work.

The term cutter head as used above refers only to grinding valves as shown in Figs. 3 and 3′ and no cutters are used. The only head having cutters is for bevel seats—this head being shown in Fig. 4.

Otto Dorthen.

Support for Foundation Bolts

The illustration herewith presents a simple and effective way of supporting foundation bolts in a vertical position while the concrete is being poured.



METHOD OF SUPPORTING FOUNDATION BOLTS WHILE POURING CONCRETE

The height of the wooden block is equal to the desired projection of the bolt above the foundation.

Roy H. Poston.

Ignorance in Power Plants

As a general rule, power plant men are credited with brains and the ability to use them; but I have discovered a case where such is not the truth. A certain fireman who has fired the same boiler for 20 yr. claims he cannot put in a gage glass. Nobody can prove to him the efficiency of a correct design and height of furnace bridge wall for hard coal. He says the lower it is the better. Also, he claims that weights on his safety valves are about 300 lb. each, for a 6-in. valve with a 54½-in. lever. Boilers "pop" at 115 gage. The boiler feed pumps were packed by the writer recently and as soon as this wise guy came on, he screwed the glands up so tight that it was necessary to use a long wrench and shaft hammer to start them.

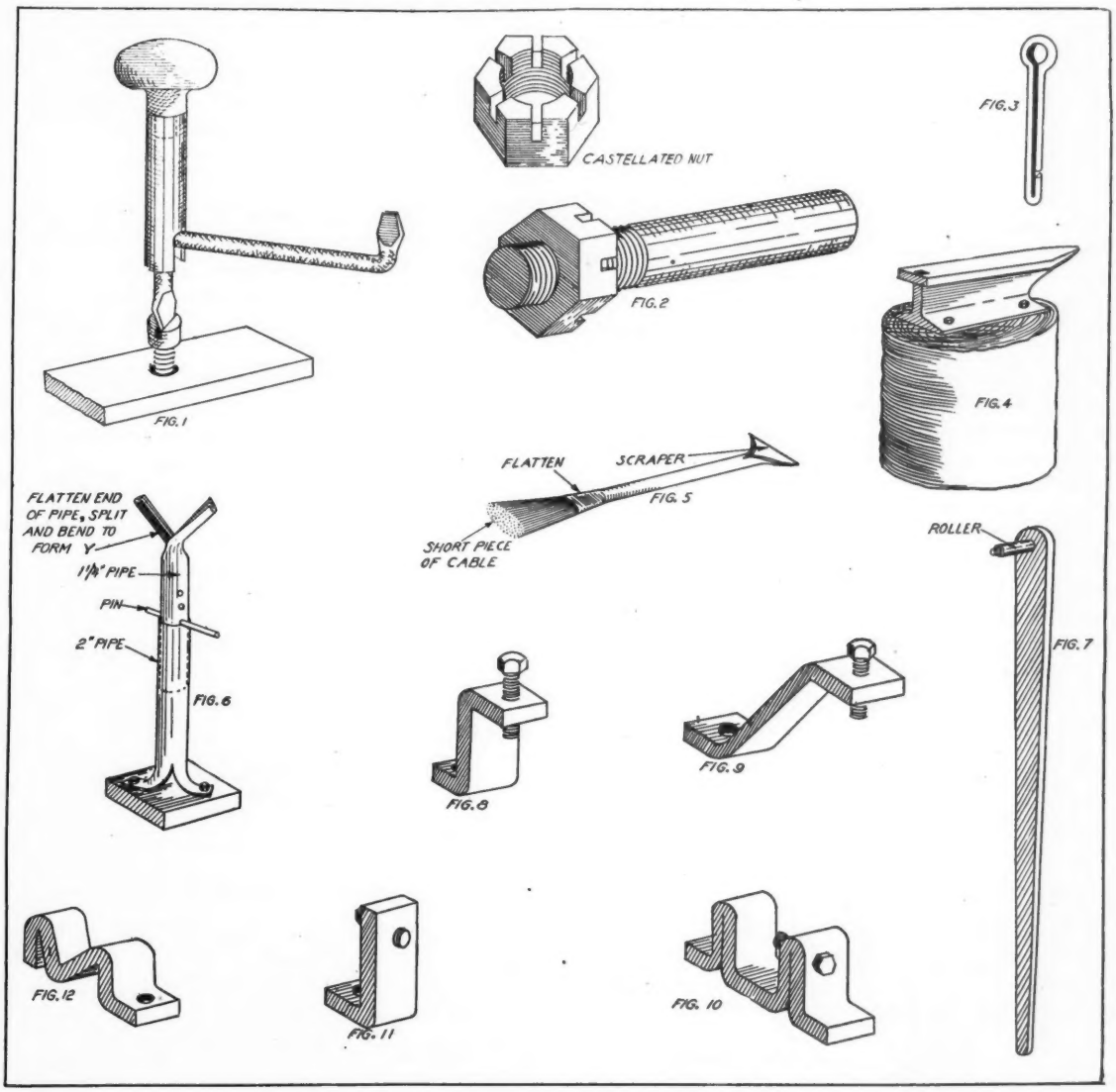
This man never reads any kind of books or magazines except the daily newspapers. I tried to get him to subscribe to journals on power plant work, but to no avail. I feel sorry for him if he ever tries to get a license, but the industry would be better off without him. This is one evidence of the need of a national license law.

Red Man.

Some Useful Kinks

FOR YEARS it has been the writer's hobby to gather useful wrinkles, helps and kinks. I never meet a mechanic, engineer or power plant man without swapping ideas and helps with him, nor visit a shop or plant without hunting for the homemade kinks. It is in this way that I have in the past gathered many clever ideas, which after sketching out I pass on to those who are interested in them.

Figure 1 is a scheme that I hit upon one day while using an offset or angle screwdriver. I desired to apply pressure on the driver and yet permit its free movement. I cut a slot in one side of a suitable short length of pipe to fit down over the round stock of the driver and used an old door knob for a handle; this is a slick tool for removing stiff screws.



A DOZEN EASILY MADE DEVICES FOR THE POWER PLANT OR SHOP

Figure 2 illustrates a good idea to use when reassembling machinery where castellated nuts are used. By

running the nut on reversed, it acts as a die and cleans the screw threads. A hardened nut makes a fair die substitute.

Figure 3 shows a self-locking cotter key made by cutting one leg short and then bending the other back over. When this pin is put in, the bent leg springs out and locks the key by the shoulder.

Figure 4 shows how one engineer provided for the plant several good anvils, making them from an old railroad rail. He cut the rail into short lengths and then cut one end of each length so as to make it pointed to form the anvil horn. This was done by drilling and then cutting with a blacksmith's chisel. A square hole was drilled and filed in the other end of the rail for the anvil hardy. Each anvil was secured to a block by lag bolts.

Figure 5 is a useful, cheap cleaning brush. It is made cheaply and easily from a short piece of pipe and some old hoist cable. The cable (two pieces) is put into the pipe end, the pipe being made oval to receive them, and by pounding it down after they are in holds them tightly. By untwisting the cable strands, a brush is made. By splitting open one side of the other end of the pipe and opening it out flat, it makes a good scraper for loosening up dirt.

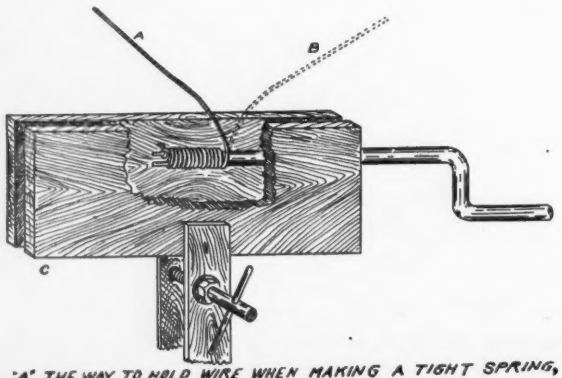
A very good work support for pipe or bar stock is quickly and easily made from two pieces of old pipe or boiler tube of different diameters and a baseboard or heavy plank, as shown in Fig. 6.

For replacing belts on revolving pulleys a long reach belt stick is a time and labor saver as well as a safety-first wrinkle, and by making the stick as shown in Fig. 7 with a roller in place of the stationary stud, the device is efficient; the roller can be made from a lag screw and a piece of pipe, or a special bolt can be made for the purpose.

Figures 8 to 12 show some handy tools for use on the drill press table for securing work while drilling. To any mechanic or engineer their uses are obvious without description. They are all made at the forge and bench from flat bar stock of ½ by 3 in. C. H. W.

A Novel Spring Winder

In the accompanying drawing is shown a device which I perfected for the making of small springs.



"A" THE WAY TO HOLD WIRE WHEN MAKING A TIGHT SPRING, "B" WHEN MAKING A LOOSE SPRING. "C" 2 PIECES OF SOFT WOOD, ONE ON EACH SIDE OF SPINDLE, CLAMPED INTO VISE

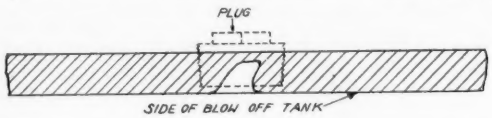
SPRING WINDER AND METHOD OF USE

Essentially it consists of two boards between which by means of an ordinary bench vise I clamp an iron rod of the form indicated and with a slot cut at one end. With the parts assembled, one end of the spring wire is inserted in the slot, after which the handle is turned the required number of times to produce the length of spring desired.

If a short spring is wanted, the spring wire is held away from the handle; while if a long one is desired, the wire is held toward the handle. R. F. Mueller.

Quick Repair to Blowoff Tank

We recently put into service a cast-iron blowoff tank. After about 6 mo. a leak appeared in one of the side plates and investigation showed that it was a flaw or sand hole somewhat as indicated in the sketch herewith, the hole on the outer surface being only about



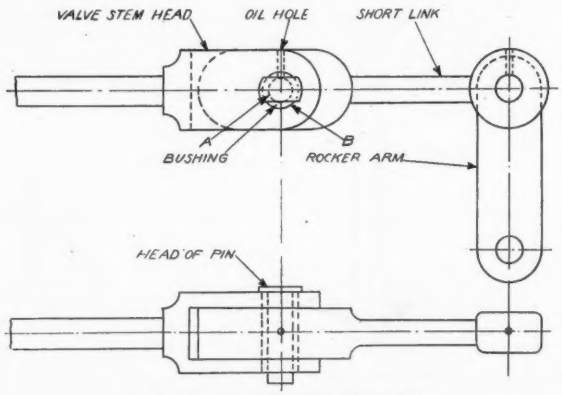
SHOWING HOW REPAIR WAS MADE

1/16-in. while on the inside it was almost ¾-in. in diameter. We found the plates to be about ½-in. thick so we repaired it by reaming out the hole to 1 in. and threading it to receive a 1-in. plug as shown.

M. A. Saller.

Repairing Valve Stem Head

When the bearing of a valve stem head wears, it assumes an oval shape, which is often the cause of considerable lost motion in the valve gear.

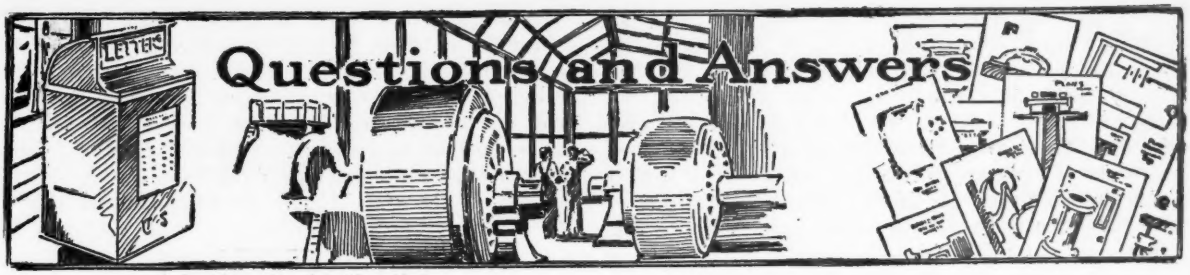


METHOD OF FITTING BUSHING

To remedy this defect, first bore out the hole to a diameter equal to the length of the oval; then fit a brass bushing, making it a driving fit in the hole and a bearing fit on the pin. In the sketches, A is the original size of the hole, while B is the size after boring.

H. Weinberger.

Five hundred Armenian women, employed by the American Red Cross, have built 100 mi. of stone roads in Mesopotamia and reconstructed several steel bridges within the past four months to facilitate transportation of Red Cross supplies.

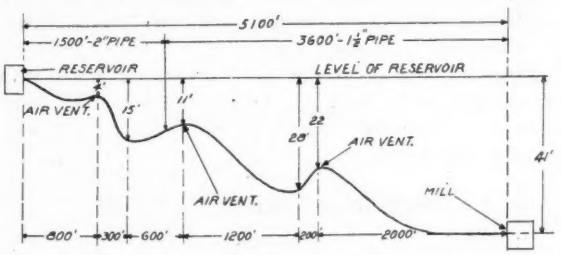


Why the Stop in Flow?

IN THE accompanying sketch is shown the elevation of a pipe line from our reservoir to our mill. The point of outlet at the reservoir is 41 ft. above the point of discharge and, after the line was installed, we had a satisfactory flow for some time. Of a sudden, however, the flow stopped and, as the cause of this peculiar action has been a puzzle to me, I am appealing to the readers of Power Plant Engineering for an explanation.

We installed this line about one month ago, using 2-in. pipe for a distance of 1500 ft. and reducing it to 1½-in. from that point on; we get a ¾-in. stream from this pipe.

The water ran satisfactorily for 2 weeks, but within 4 hr. stopped entirely.



ELEVATION OF PIPE LINE FROM RESERVOIR TO MILL

We have already removed all the sections of this line, but fail to find any obstruction which might interfere with the flow of water. However, 7 hr. after the last section was again put together, flow was re-established.

What is the cause of this?

PERPLEXED ENGINEER.

Cause of Boiler Pitting

REPLYING to the inquiry of N. E. in the Oct. 15 issue in regard to the cause of boiler pitting, I would say that the continuous dripping of the leaky joint directly on the tubes would cause pitting of tubes or any other part of the metal with which that it comes in contact. He should stop the leak at once, and paint the pitted or honeycombed tubes with a thick coat of red lead and boiled linseed oil, and do this from time to time; this will prevent their pitting more.

In regard to the scale forming on one side of the boiler or bank of tubes it is rather a hard question to answer without looking at conditions inside of his boiler, as he did not say where the feed water entered his boiler water. We have trouble with scale-forming on tubes about three rows wide and four or five deep where the feed water is discharged. If this is the cause of his scale forming trouble, I would say that if the feed water pipe enters the boiler head just above the top row of tubes, a tin pan about 24 by 36 in. by 1 in. deep should be placed under the delivery pipe. The water will discharge into this pan and overflow, allowing the sediment to settle in the pan, which can be taken out and cleaned each time the boiler is cleaned. I think he will find this will stop the scale trouble, provided it is caused by the feed water, which I think is the case, as tubes are not likely to become so scaled in one place with a good circulation in the boiler.

The proper place for feed water to discharge is to have the feed water pipe run about half the length of the boiler, inside, with an elbow and a piece of pipe running to the center of the boiler, then an elbow and a piece of pipe running down to the bottom row of tubes. Some engineers claim the pipe should run the entire length of the boiler with an elbow and a pipe running across the back end of the boiler and discharge the water between the outside row of tubes and the shell. I do not think this advisable, as scale will form all the way down on these tubes, a hard place to clean. I think that most engineers who have cleaned a boiler that is anywhere from 100 deg. F. up, will agree that it is no pleasant place to work.

I hope that this will help N. E. and any other engineer that has the same trouble. LESLIE KLOCK.

WITH REFERENCE to N. E.'s letter on boiler pitting, I wish to state that if he had been a little more explicit, the writer would have been in a better position to analyze his trouble; however, I will answer it in a broad way and possibly some of my suggestions will fit his case.

As a matter of fact, water is never pure, except when purified in the laboratory, or by distillation. Impurities can be divided into four classes, mechanical, gaseous, dissolved mineral, and organic. I surmise from his statement that the dissolved mineral impurities fit his case best. I will not go into detailed explanation as to the four classes referred to, but roughly analyze the probable causes only from the information he has given. A heavy scale on one side of the tubes of the boiler shows conclusively that there has been more circulation of water through that portion of the tubes, and when traced further, it clearly demonstrates that more heat units are passing through those tubes than through the other portion of the heater. This carries us to the fire box or furnace. It may be possible that his grates are in bad condition, in the opposite portion of the furnace from that part corresponding to the tubes which are scaling so badly. The grates may be choked up so that there is not an equal distribution of heat units over

the entire grate surface, and the bulk of it is going through these tubes, causing the boiler, in other words, to do the bulk of its work around this nest of tubes. The pitting could be caused by the condition of the water, or by water which has been used over and over several times from a condenser, making it too pure. Water of this nature is troublesome, and will always pit boilers. In that case, it is easy to correct by adding about 25 per cent fresh water to the water from the condenser. A slab of zinc, bolted inside of the boiler just below the water line, will often prove beneficial.

I would take some of the scale, say a pound, and about a gallon of the feed water after it has left the heater and send it to a chemist and have a correct analysis made, when a proper boiler chemical can be made up to treat this water, not the boiler. This chemical system is operated by having a 50-gal. elevated tank with a pipe connection to the feed water heater. It is filled daily with, say, 49½ gal. of water with ½ gal. of the chemical mixed into it. This is allowed by gravity controlled by a valve to run continuously into the heater at such a rate that it will last throughout the entire day.

H. W. ROSE.

Causes of Missing Cylinder

I NOTE on page 939, Oct. 15 issue, L. A. E.'s cylinder trouble question; also the editor's reply. I have had considerable experience along this line, and have located the trouble in the connection between the gas intake manifold and the cylinder, not being perfectly tight, or the packing in bad shape. This would allow an excess of air to weaken the gas to a stage that would produce the trouble he mentions. Adjust the spark plug points the same as the spark plug of the other cylinders, and then renew the packing between the cylinder and the intake gas manifold connection, and I am of the opinion that his trouble will be eliminated. H. W. ROSE.

Calculating Thickness of Ogee Flange

WILL YOU kindly inform me as to the method of calculating the thickness of plate required on the ogee flange of Manning boilers? SUBSCRIBER.

A. There is no definite formula for figuring the thickness of the plate to be used. The present ogee flange is made far differently from the method employed when the first Manning boilers were built.

For the purpose of checking up this thickness, however, and to have some method of arriving at a proper thickness for a certain size boiler and a certain pressure, the writer has generally used the regular shell formula, using it as follows:

$$T = \frac{W.P. \times R. \times F.S.}{T.S. \times \text{eff.}}$$

in which T is thickness of ogee flange, W.P. is working pressure of boiler, R.—radius of shell or barrel, T.S.—tensile strength of the plate, F.S.—factor of safety=5.

The efficiency of joint is neglected, owing to the fact that ogee is one piece, the efficiency, therefore, being 100 per cent.

Naturally, this will figure out less than the thickness of the shell or barrel; but, due to the form of the ogee and its short length between gage lines of rivets, this makes it amply strong to take care of the pressure.

It has been customary, on boilers built for 150 lb. pressure and below, to make this ogee flange as thick as the shell and in some cases slightly thicker. One reason for this is that the ogee flanges are usually made up in stock for pressures from 150 to 200 lb. These are then used as standard for all sizes of boilers including those ranging below 150 lb. pressure.

THE BIGELOW CO.,
G. WELTER.

Expansion of Steam Lines

WILL A steam pipe, say, 1½ or 2 in., expand more than ½ in. on a length of 300 ft.? What will be the condensation in a steam line 300 ft. long for 1½ and for 2-in. pipe; boiler pressure 100 lb. per sq. in. and temperature outside of pipe 32 deg. F.? F. W. K.

ANSWERS

A STEAM PIPE of 300 ft. length will expand 0.0019 in. per degree Fahrenheit rise in temperature. As you do not state what the temperature of your steam is, we are unable to figure this out for you.

The condensation of a bare steam line is found as follows: First, find the B.t u. loss per hour by multiplying together the area of the surface of the pipe in square feet times three, times the number of degrees Fahrenheit difference in temperature between the steam and the outside air. The latent heat of steam at 100 lb. gage is 879 B.t.u. This means that to condense 1 lb. of steam it is necessary to remove from it 879 B.t.u.; therefore, dividing the total B.t.u. loss per hour by 879.8 will give the number of pounds of steam condensed per hour which is, in your case, 34.8 lb. for a 1½-in. pipe, or 44.3 lb. for a 2-in. pipe.

Determining Intensity of Draft

KINDLY give me a formula applicable to determine the intensity of draft knowing the height of the stack and the temperatures of the atmosphere and the stack gases. READER.

A. The theoretical force or intensity of draft D, in inches of water, obtainable from any stack, is equal to $0.52\ P\ H\ [(1 \div T) - (1 - T_1)]$; where P is the atmospheric pressure, pounds per square inch; H is the height of stack above grates, in feet; T is the atmospheric temperature absolute, degrees F., and T is the temperature of stack gases, absolute, degrees F.

A Worn Grinder Shaft

WE HAVE a steel-carting grinder consisting of two wheels mounted on the ends of a 3-in. shaft which also carries at its center the armature of the driving motor. The copper oil rings with which this is fitted have worn grooves around the shaft in spite of the abundant amount of oil supplied.

Could you tell me the cause of this and how I may avoid it? L. A.

A. The trouble which you are having with the wearing of your armature shaft is, we believe, due to the presence of dust and abrasive particles.

With the arrangement of emery wheels employed, it is quite obvious that more or less of such dust and abrasive particles will find their way into the bearing, and as a consequence will cause not only considerable wear of the shaft, but also of the bearing itself.

If you have not, at present, such an arrangement, we would suggest that you provide these bearings with some form of sheet metal housing, fitting the openings in this housing through which the shaft passes, with some form of felt washer, so as to avoid the possibility of any foreign substance entering the bearing.

We believe by employing such a housing, your trouble will be eliminated.

Determining Pitch Diameter of Gears

I HAVE a gear with 14 teeth, 2½-in. pitch. Kindly show by example how to find the pitch diameter.

T. D.

A. You do not state whether the 2½-in. pitch of your gear is diametral pitch or circumferential pitch. If it is diametral pitch, the pitch diameter would be 14 divided by 2.5 or 5.6 in. If it is circumferential pitch, the diameter would be 2.5 multiplied by 14 divided by 3.1416, and the pitch diameter would be 11.1 in.

Allowable Turbine Bearing Temperature

I AM OPERATING a Curtis steam turbine, the temperature of the bearing oil of which reaches 158 to 160 deg. F. Is this too high?

Oil suggested by the manufacturer is used. The temperature of the turbine room is always about 110 deg. F. J. H. McK.

A. The temperature of the oil in your turbine, it seems, is considerably higher than it ought to be, but we are afraid that this is due to the exceedingly high room temperature of 110 deg. F. under which you are required to operate.

If your oil is of the kind recommended by the manufacturers of your turbine, your bearings are in good condition and your oil cooler is working efficiently, we can see no other way in which you may be able to remedy your trouble than the lowering of your room temperature. If this cannot be done, then of course you will have to be satisfied with running the temperature of the oil at from 158 to 160 deg. F.

For your information we would state that under no conditions, if such can possibly be avoided, should the temperature of the oil coming from your bearings exceed 150 deg. F.

Boiler Pitting Difficulty

RECENTLY I have noticed many small blisters on the flue surface of our boilers and upon opening the blisters the metal is always found more or less pitted.

What is the cause of this?

Can you suggest a remedy? F. I. F.

A. The pitting of your flues is possibly caused by acid in your boiler feed water. This can be to some extent neutralized by the use of carbonate of soda in sufficient quantity to cause the water to turn red litmus paper blue. The fact that these pits are formed under what you term blisters is due to action similar to corrosion of metal covered by the oxide left on the surface in its manufacture.

This oxide while it is in a perfect condition protects the metal, but the least minute crack sufficient to allow water to reach the surface of the metal is likely to cause pitting. This pitting may also be caused by the use of unsuitable boiler compounds, such as those containing tannic acid or sulphate of copper. Of course, it is impossible to state definitely just what is the trouble with your feed water, and we would therefore suggest that you secure some book on this subject, such as "Boiler Waters," by Christie, which is published by the D. Van Nostrand Co., 25 Park Place, New York City, at $3.

Operation of Deep Well Pumps

I AM GOING to call on you to settle a pump question. A man was telling me that the well on his father's place in Nebraska is 67 ft. deep with the cylinder of the pump down 6 ft. from the top. It is a common pump such as used on farms.

I told him that he must be mistaken. He then told me that he knew of wells 150 ft. deep with the pump cylinder not over 40 ft. down in the well, and the pump worked satisfactorily.

After hearing all this, I went to the chief engineer about it and he tells me that he has pumped water 52 ft. with a pitcher mouth cistern pump, and 75 ft. from a mine shaft with a duplex steam pump. I asked him how, and what brought the water up into the pipe. He said he did not know.

Now I have always understood that the working principle of a water pump is that suction excludes the air from the pipe and the atmospheric pressure forces the water up the pipe into the valves where it is then forced up and out of the discharge.

As I understand it, water will rise about 34 ft. in a perfect vacuum, but it is impossible to get a perfect vacuum with a water pump and about 28 ft. is the limit water can be pumped, and then the pump must be in first class condition; also that the average pump will not work satisfactorily over 23 ft. J. M. M.

A. If an ordinary water pump is located, say a distance of 50 ft. from the level of the water to be raised, it would be possible only to raise this water to a height of 34 ft. If, however, a hole were made in this pipe a short distance above the water line, it would be possible to raise the water to a considerably greater height than 34 ft. depending upon the amount of air mixture with the water.

Allowing air to enter the pipe in this manner, causes the air and water to form in alternate layers, and the column of water which would have a weight equal to the pressure of the air is therefore, considerably increased.

It is on this principle that deep well pumps operate. The well you mention as being 67 ft. deep is possibly of that depth measured to the bottom of the body of water. The water level, however, may be of some distance above this point, as the usual method of measuring a well is the depth to the bottom of the well rather than to the level of the water.

IT IS announced from Vienna that the government has issued an order restricting all activities dependent on coal.

ANNOUNCEMENT COMES from Fall River, Mass., that the Charlton mill has put an oil burning plant into practical operation with satisfactory results.

POWER PLANT ENGINEERING

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A Broader View Needed

This world is big, too big for any of us to get off and look at it as a whole; it becomes necessary for us, therefore, to study its workings from our individual spheres of travel and the knowledge we gain from those who have had other experiences than ours. In the civilization of today our lives are influenced by so many conditions over which we as individuals have little or no control, that men have banded themselves together into groups—geographically, socially, professionally and otherwise—in order that their combined efforts may result in the accomplishment of some desire of that group. The desires of any group are usually intensified by a few influential leaders in that group who, through their knowledge of human nature and powers of persuasion, are able to get the concerted action they desire on the part of the group.

The tendency of such organization is narrowing to the individual; he puts too much dependency in the thought and words of the leaders of the groups with which he is associated, allowing them to do all the thinking, while he himself must bear his share of the responsibilities of his group. Leaders become warped in their views because of their intensive thought and efforts to accomplish aims, of themselves beneficial to the group, but too frequently of detriment to the general welfare of all those whom these aims affect.

It is no longer practicable to take the attitude of "me and my wife, my son John and his wife, us four and no more." Social conditions are such that one family must depend upon the work of another, one town upon another, one nation upon another, and one trade or profession upon another. Each group has its functions to perform, but there is danger of some few groups becoming so strong in numbers as to be able to force advantages out of harmony with our scheme of civilization.

To counteract such dangers, each individual should interest himself in things directly and indirectly related to his own work. If he were able to get off and view, impersonally, the whole industrial machine of which he is a part, he could then get a knowledge of the relative importance of his work and could not readily be persuaded to support measures proposed by members of his group which would put his group out of harmony with all others.

It is, therefore, the broader view which we need among the individuals of our industries, in order that stable conditions may be established. As a whole, the engineers in power plants do their own think-ing and are seldom found in the radical class, thoughtless of other professions. For this reason the engineer's opinion is respected by his associates, and his influence is probably far greater than he realizes. It would be well, therefore, for him to use that influence among his associates, to cultivate in them the habit of logical, broad-minded thinking, and thus do his share toward bringing industry out of its almost chaotic condition.

For a sick man, the doctor frequently prescribes a series of exercises or interests which will take the patient's mind off his daily work. The sick industry of today needs just such a prescription. The individual who gives a valuable service to the community, state or

nation through associations, church, community center, who does his own repair work about the home, who has a hobby like gardening, photography, model-making, who cultivates an interest in mechanical drawing, mathematics, science, literature, history, home and community hygiene, national economics, who takes regular healthful exercise and entertainment, will find his vision broadening, his thinking more logical and his influence growing. His trade or professional standing need not suffer in the least, but he will find life worth far more to him than when his interest is confined to work for which he is paid in dollars and cents.

Let us strive for this broader view.

What Others Are Doing

The power plant industry of the world is growing rapidly, not only in magnitude but, fortunately, in the efficient use of natural resources. A survey of the important undertakings in various countries reveals how widely the problems differ in various localities. England, with her coal mines, is planning super power stations; Holland, without coal and water power, expects to develop wind power to the limit; Norway, Sweden and Finland will use water power more extensively; Russia is expected to develop peat bogs; Spain will be a network of transmission lines connecting water and steam plants with industrial centers; Italy has her natural volcanic steam. All of these countries are apparently going to the limit of their finances to develop power.

Before the war, human labor in Europe was cheap, hence many of the processes done here mechanically were there done by hand. Now this condition has changed, and the demand for power has increased for this reason as well as for the expected increase of industrial output.

For years, Europe has used its coal to develop more power per pound of fuel than has been the practice here. With increased prices of coal, we shall be compelled to obtain equal economies. Why should we delay in saving our fuel until necessity demands it? The means are available and the reward immediate.

We shall all watch the developments in power projects cited on another page of this issue with interest and we have no doubt American engineers will not be long in making use of any new ideas which work for increased economies in these new plants.

The Price of Success—and of Failure

Our Maker has yet to endow man with vision capable of viewing what is to come. Had we the faculty of seeing what the future holds for us, life would hardly be worth the living. To know what is to be our ultimate status in the business world, would rob life of its zest—of its tenseness. Some of us would as soon pass to our end and have is done with; but, happily, no man can know his future. A man's ambition is what makes or breaks him in the eyes of the world and he is his own maker in that respect. It is up to him and to him alone, to prepare himself with technical and practical knowledge sufficient to see him through the dark days we all are sure to meet with on the road to success. Otherwise, whom has he to blame for dismal failure? Whom has he to blame when he raises the cry, "I never had a chance?"

The chance is within every man's grasp, no matter how lowly, for history has proved that presidents, lawyers and statesmen are made, not born. What force was responsible for their successes? It wasn't "pull." No! Just pure, plucky, dooged persistence was what brought them to the pinnacle of fame.

In order to prove the infinite value of a technical education to the young man about to embark, or already having embarked upon an engineering career, I want to say that the following is taken from life. I have watched these young men from the day they first stepped into my office and their lives are a good example of the difference between success and failure; of what can be accomplished by study, persistently stuck to; and the ultimate end of the man without true ambition.

For obvious heasons, let us call the two principals Dick and Harry. Both were bright, wholesome boys just out of high school. Dick would have given much for a college training, but dependents at home would not permit of it. Harry wished to go to work for the money there was in it. Thus it was I took them under my wing. Could these boys have looked into the future, Dick would have been elated, Harry should have hung his head in shame.

While they were familiarizing themselves with the construction and operation of boilers, engines and other power plant equipment, I suggested that they enroll for a technical course in their chosen profession. Dick jumped at the idea. Harry scorned it with the assertion that he was learning fast enough to suit him and had much rather have his evenings in which to "get out with the boys." I said nothing more. I had sown the seed from which ambition could take root and in a short time found that in Dick the seed was flourishing and in Harry failed even to germinate.

Months passed. Dick had finished his course with honors and not content with this showing, had enrolled for another. Harry was still content to waste his precious time. Then it was that Opportunity knocked. The management, finding need for a technical, as well as practical, man, asked me to find one for them. In all fairness to myself and to the firm, I recommended Dick. Harry came to me and accused me of showing partiality. I tried to reason with him but it was useless. Anger drove all thought of fairness from his mind. Later I advised him once more concerning his technical education; this time the seed rooted, but in a few weeks withered and died. The call of the "boys" was stronger than that of success. Soon Harry took to drink and before long I had to let him go for incompetency.

Meanwhile Dick had made good and the management, realizing his sterling worth, took it upon themselves to advance him as swiftly as circumstances would permit. There is no telling where Dick will stop, and, sad to say, no telling where Harry will eventually end unless he takes a fresh hold upon himself. There is a certain amount of satisfaction in feeling that I was instrumental in Dick's success, but how much better I would feel could I but see each of them striving, with friendly rivalry, to outdo the other in life's race.

A Labor-Saving Jack

ANOTHER useful addition to the long list of labor-saving devices, is the pole pulling and pole straightening jack illustrated in action. This tool has recently been improved by the addition of a more perfect control for the lowering movement. It is claimed that with this jack one or two men can pull the largest pole, regardless of depth, soil, or weather conditions, in a fraction of the time it takes the usual gang of 5 or 6 men to do the work, also, that one man can straighten a pole in 1 min., that usually takes several men several minutes.

POLE PULLING JACK IN ACTION

Somewhat similar is the Simplex emergency jack which has included in its equipment, several lifting and pushing points and attachments.

A Triple-Blade With Hole Cleaner

ONE of the most difficult tasks in connection with cleaning out a water-tube boiler, of the type which has a handle opposite the end of each tube, is removing the scale from the inside of the handhole plate, to provide a good bearing for the gasket.

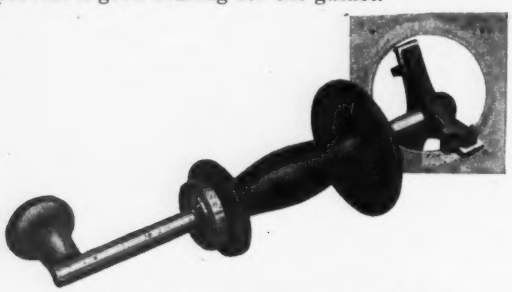

FIG. 1. CLEANER ENTERING TUBE-HOLE

To save much of the time spent in doing this work in boilers which have a flat gasket surface, is the purpose of a device, now on the market, known as the Triple-Blade Tube-Hole Cleaner.

This device consists essentially of three blades mounted in the arms of a spider, which in turn is mounted on a spindle, extending through, and having a bearing in a body so shaped as to afford a convenient hand grip for holding in position against the tube plate. The spindle is jointed at such a point that when the body is in place against the outside, and the cutters are drawn up against the inside of the handhole plate, the outer end of the spindle may be swung over to act as a crank for driving the cutters. A roller mounted on the spindle bears on the outer end of the body, acting as a fulcrum to provide the necessary pressure on the blades.

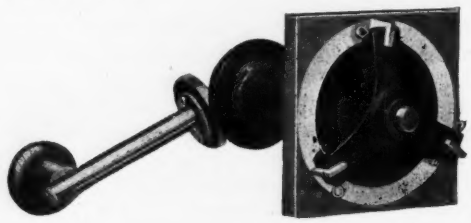

FIG. 2. BACK VIEW OF TUBE-HOLE CLEANER IN OPERATING POSITION

The application of this device is shown in the illustrations herewith. The makers claim that a saving can be made of ⅔ of the time necessary for cleaning by hand.

Don't Break His Spirit

THE MAN or woman who criticizes to the extent of damaging the future of a disabled soldier, sailor or marine is deserving of but small consideration. Yet instances of such criticism are met with daily by the Federal Board for Vocational Education.

Don't tell a handicapped soldier, sailor or marine that the Government is not trying to help him. You are possessed of a strong body; exert your strength to the extent of seeing that the handicapped man meets an officer of the Federal Board for Vocational Education.

Don't dismiss the matter with a wave of your hand. That handicapped man gave his all, sacrificed his future to help you retain your strength and vigor. Every citizen of this country who did not go to war should extend a helping hand to the man who did.

You know that the Government has provided for the rehabilitation of our disabled men. You are a part of the great Government which is providing such training, so every time you fail to help the disabled man to get in touch with the institution which has been established for his benefit, you are furthering the German cause and proving unworthy of the citizenship you so proudly boast of.

Remember that your criticism may destroy the faith of some man who suffered so that you might prosper; that a maimed and broken body produces a timid and warped spirit; that souls have perished through criticism which destroyed faith.

IN AN ADDRESS before the Cost-of-Living Conference at Boston State House, Oct. 24, Attorney General Palmer stated that 99 men out of 100, in both retail and wholesale business, were "taking only a fair profit," and said that it was the Department's policy to ask honest business men to enforce laws against profiteering. Mr. Palmer declared that this policy was to be worked out through fair-price committees in every city and county throughout the United States.

CHARLES M. SCHWAB intimates that the railroads of the country will need approximately 5,000,000 tons of steel rails during the next 12 mo.

International Power Economy Conference

TO DISCUSS the best means of helping to conserve fuels and increase power plant savings.

This second meeting of the Conference opened with the coal miners' strike impending, which emphasized strongly the need of such work as it had in view.

In calling the meeting to order, R. A. Gray, vice-chairman, told of the attitude of Dr. Van H. Manning, Director of the Bureau of Mines, who is heartily in sympathy with efforts for fuel conservation and will co-operate with any organization which has real possibilities to offer. The plan proposed by David Moffat Myers for inspection of coal to determine its variation from a standard set by the producing mine would involve some $1,000,000 expenditure the first year, and as the Bureau of Mines, which has inherited the policies but not the powers of the Fuel Administration, has neither power nor appropriation for the work, it has been impossible to do anything this year.

Discussing possibility of co-operation with government departments, F. A. Moreland pointed out that the Fuel Administration is not legally dead, and that to put the Bureau of Mines in position to do effective work involves Congressional action, which will only come in response to public demand.

This demand, as shown by Joseph Harrington, is awakening because of the increase in cost of fuel, but the public is not yet awake to the full need of conservation or the possibilities, and education is needed before an effective system of coal inspection and plant supervision can be authorized and put in force.

David Moffat Myers emphasized this point and showed that the saving of 100,000,000 T. of coal a year which can be effected, worth, at $6 a ton, $600,000,000, is a matter not to be neglected. Efficiency is due to men plus equipment. The Fuel Administration, working with men of training only, was able to save 25,000,000 T. of coal during the short time it was effectively at work, and a system of ensuring fuel of known heat value, supervising plant equipment and operation to insure correct engineering, would be able to multiply this result many times. A system of licensing should be put in force looking to fitness of engineers to produce economical results, as well as to operate a plant safely.

Others spoke of the need of altruistic work, keeping the welfare of the public as the main object, accepting any business gain as a by-product. The manufacturers of apparatus designed to improve plant economy must, as in many cases heretofore, act as consulting engineers, placing their knowledge at the service of the public, so that practical results may be obtained.

Zoning in distribution was advocated by H. J. Meyer, who told of plans in a South Dakota plant to use local lignites rather than coal from distant mines, drying the moisture from 36 per cent to 6 per cent before shipping from the mines. The use of lignites in Minnesota alone would save 500,000 T. of coal a year and release 50,000 cars for other transportation. This reduction of transportation waste, as shown by B. J. Roberts, would also be helped by washing at the mines to remove dirt and sulphur; it would also reduce labor in firing, in handling of clinker and ashes; and would make suitable some low grades of coal not now available. Effect of scale on boilers, turbines, pipes and economizers was cited by M. F. Newman to show the need of water purification. Also Alfred Goetz and A. W. Knight pointed out the saving by attention to proper condition of settings, which may amount to 1 or 2 per cent of the fuel.

Wastes of fuel oil were indicated by W. G. Williams as due to drilling, distillation and burning methods, all of which can be improved. As a matter of conservation, the use of fuel oil under boilers should be decreased, all possible gasoline and lubricating elements being removed by improved cracking methods of refining, and the residue only used for fuel, probably with best efficiency in some form of internal combustion engine.

Instruments, so necessary for proper operation, are often not rightly installed or used, as pointed out by F. W. Carrett, and education of power plant men is needed in this matter. Labor must be saved, and mechanical handling of fuel and ashes is important in this connection. L. A. Griffin cited a case in one plant where the use of a steam ash conveyor for three 15-min. periods a day replaced the work of 8 to 12 men.

Principles and proper practice in combustion, and means for automatic control are essential, and G. S. Carrick showed that this entails training of man power to handle such apparatus properly.

The plant as a whole must be co-ordinated, and only by combined activity of makers of apparatus can this be best accomplished.

As to what an organization can do, it was shown that the industries use 40 per cent of the fuel of the country, while domestic uses account for only 12 per cent. A saving of a few per cent in industries will, therefore, release fuel to care for a considerable part of the domestic needs.

Reporting on a plan for future work, a committee on organization presented resolutions advocating continuance of the work of the Fuel Administration through the Bureau of Mines, dissemination of information to awaken public interest and secure governmental action, and effort to secure co-operation of the public and of civic and engineering bodies. The Conference to become an incorporated association as soon as 100 representative firms shall become contributing members. An executive committee of ten to be appointed by the Chairman, C. A. Tupper, to secure members, draw up a constitution and by-laws, and call another meeting of the Conference, at which permanent officers are to be chosen. The name favored by the meeting for the permanent organization was The International Power Economy Bureau.

A vote of thanks was extended to Mr. Tupper and his associates for their generous assistance and effective work.

IT IS ANNOUNCED from New York that, in the opinion of Stephen C. Mason, president of the National Assoc. of Manufacturers, strikes have cost the United States $10,000,000 a day in the last 8 mo.

THE TELEPHONE company of Shanghai has given up its plan of installing an automatic service, as it is found to be much cheaper to employ native operators.

Trade News

THE SARCO CO., Woolworth Bldg., New York, has issued a new circular describing the Steam Trap Sarco, which is sent free to anyone on request.

SCHUTTE & KOERTING CO. has issued a revised catalog on stop, stop check and emergency valves, and will be pleased to forward a copy to those interested.

CATALOG No. 519, describing their line of internal furnace Scotch marine type boilers, has been issued by The Gem City Boiler Co., Dayton, O.

"NATIONAL" BULLETIN No. 7, issued by the National Tube Co., Pittsburgh, Pa., contains an interesting description of the manufacture of Welding-Scale free pipe.

BULLETIN No. 110 "on the Superior Advantages of the Uheling CO_2 Meter" has been received from the Uehling Instrument Co., 71 Broadway, New York.

VOORHEES RUBBER MFG. CO., 20 to 56 Bostwick Av., Jersey City, N. J., has issued a small folder, giving details and prices on its line of Rub-Steel valves.

RECEIVED from the Moore Oil Refining Co., Cincinnati, O., a booklet describing that company's method of boiler feed water treatment.

ENGINEERS interested in grates may secure, for the asking, a copy of "Clear-Cut Grates" from the Marion Foundry Corporation, Marion, Ind.

THE "ELLCEE" Boiler Compound Feeder is described in a small folder issued by Lynch-Clarissey Co., 3211-13 So. Wood St., Chicago, Ill.

CENTRIFUGAL PUMPING machinery made by the Lea-Courtenay Co., Newark, N. J., is described in that company's latest bulletins, H-4 and S-5.

BUDD BUSHINGS are the subject of a folder received from the Budd Grate Co., 2011-13 Letterly St., Philadelphia, Pa.

CONDENSITE COMPANY OF AMERICA has recently issued a booklet describing its product, its uses and methods of molding it. Those interested may secure a copy by addressing the firm at Bloomfield, N. J.

A NEW CATALOG has been received from the Clarage Fan Co, Kalamazoo, Mich., which gives, besides descriptions of its line of fans, some useful data in connection therewith. Copies are available for those interested.

J. C. HORNUNG, 343 S. Dearborn St., Chicago, has recently issued bulletin No. 14, describing a line of pressure and temperature controlling appliances for central steam heating systems.

CIRCULAR No. 100, describing the Ashton Valve Co.'s line of pressure gages, has been received. Copies may be had by addressing the company at 161-179 First St., Cambridge "C," Boston, Mass.

THE LUNKENHEIMER CO., Cincinnati, O., has published a small booklet describing its line of oiling devices for engine and machinery bearings, copies of which are free on request.

STEAM TURBINE BLADING is the title of Bulletin No. 1104 published by the Allis-Chalmers Co., Milwaukee, Wis. Construction and testing of various blade forms are described.

THE VASIL HAND STOKER and Smoke Consumer is described in a recent circular of the Vasil Steam Systems Co., Washington, D. C., a copy of which may be had for the asking.

"CRUDE OIL, Its Derivatives and Uses," is the title of an interesting booklet gotten out by Lynch-Clarissey Co., 3211 So. Wood St., Chicago, Ill., which describes, briefly, the method of refining crude oil.

A CIRCULAR describing three new grease cups has been received from the Standard Mfg. & Sales Co., 1325 Arch St., Philadelphia, Pa. One is made of glass, so as to allow the feed to be watched.

EARLE CENTRIFUGAL PUMPS are the subject of the latest publication of the Earle Gear & Machine Co., Wayne Junction, Philadelphia, Pa., copies of which may be had on request.

THE PREMIUM METAL & PACKING CO., Wilkinsburg, Pa., recently issued a small booklet entitled "Facts About Premium Aluminum Alloy Bearing Metals," which will be sent on request to those desiring a copy.

J. H. WILLIAMS & CO., Brooklyn, N. Y., has just issued a catalog of 160 pages, fully illustrating and describing its standard stock specialties and containing a description of the drop-forging process in very simple, non-technical style for the benefit of those not conversant with its details.

BAILEY METER CO. sends us a copy of its latest bulletin entitled "Fluid Meters for Low Pressure Gas and Air." Those interested should write the company at E. 46th St. and Euclid Av., Cleveland, O., asking for bulletin No. 30.

THE FOXBORO CO., Inc., Foxboro, Mass., has issued Bulletin No. 104-1, describing the company's complete line of temperature recording devices, including an improved style of dial for the indicating type instruments. Copies may be had on request.

"COAL" is the title of the latest publication of the Under-Feed Stoker Co. of America, containing 32 pages, 23 of which are devoted to interesting data on coal of various kinds. Copies may be obtained by addressing the firm at its general offices, Brook Bldg., Detroit, Mich.

THE M. P. L. PACKING & SUPPLY CO., Inc., 120 Liberty St., New York, has recently changed its name to Imperial Packing Corporation, a name more easily found in telephone and other directories and more easily remembered. The corporation has also increased its capital in order to push more aggressively its Herringbone packings and other lines.

LEA-COURTENAY CO., of Newark, N. J., has recently issued two new bulletins—one, termed H-4, a veritable treatise on centrifugal pumps as well as a catalog of the company's most complete line. The other bulletin, S-5, is a synopsis of typical centrifugal pumps installed in various industries. A copy of either of these bulletins may be had on application to the company.